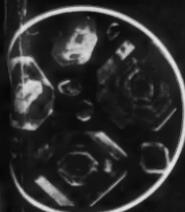
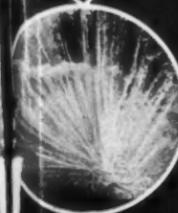


# CHEMISTRY



JANUARY  
1952



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# The Mystery of Soil

► SOIL, although "common as dirt," is actually a material about which very little is known. Is it organic? It is formed in part out of organic compounds which can be separated from it, yet intrinsically it is weathered-down rock. Many living forms, from the soil bacteria through the newly appreciated *mycetes* to the highly organized earthworms, take part in the formation of soil and are in turn nourished by it. Soil is that material which results from these many processes.

Man, of course, has lived on and exploited soil for many centuries, although not from the beginning of his career. Agriculture may actually be one of his later inventions, preceded by such classics as the discovery of tools, the invention of language, the mastery of fire and the organization of society into families and clans. Farming, with its corollary, the domestication of animals, held the forefront of achievement for a long time, until its recent jostling by the application of power to machines, and the most recent event in this series, unlocking the nucleus of the atom.

Yet in all the centuries that man has dug in the soil, he has had to take it pretty much as it came. If it was of good quality, he could thank the gods. If it was too dry, he could water it more or less satisfactorily. The sites of ancient civilizations are marked by broken-down irrigation projects and advancing deserts. Further than that, he could work it or leave it, and leave it he did, as the migrations of history attest.

After all this time, it may now be possible to learn some fundamental things about this mysterious substance on which we live. The new chemical described in the first article of this issue of CHEMISTRY may make it possible, for the first time, to distinguish between the roles of living and non-living agents in soil formation. Some of the effects long thought to be due to some living process, chemists now find dependent mainly or wholly upon the structure and texture of the soil.

Aided by the chemist's new "eye," radiocarbon, and this remarkably inert but potent soil conditioner, soil research should prove a fascinating field for new discoveries in understanding what goes on so quietly beneath our feet.

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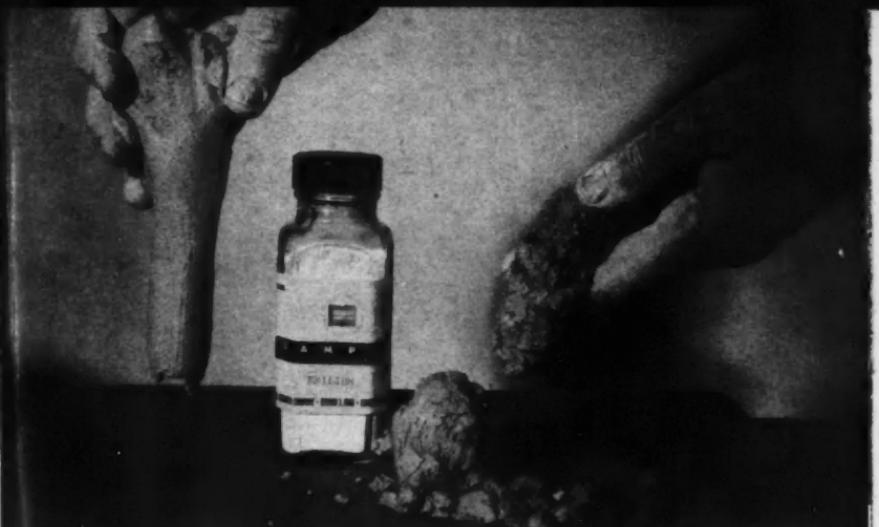
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—Photo by Fremont Davis

►CLAY which is dense and sticky, like that at the reader's left, makes good ceramic ware, but poor gardens. Some of the same clay, treated with Monsanto's new soil conditioner, Krilium, is shown breaking up into the grainy structure which forms porous soil.

## Krilium for Crops

by HELEN M. DAVIS

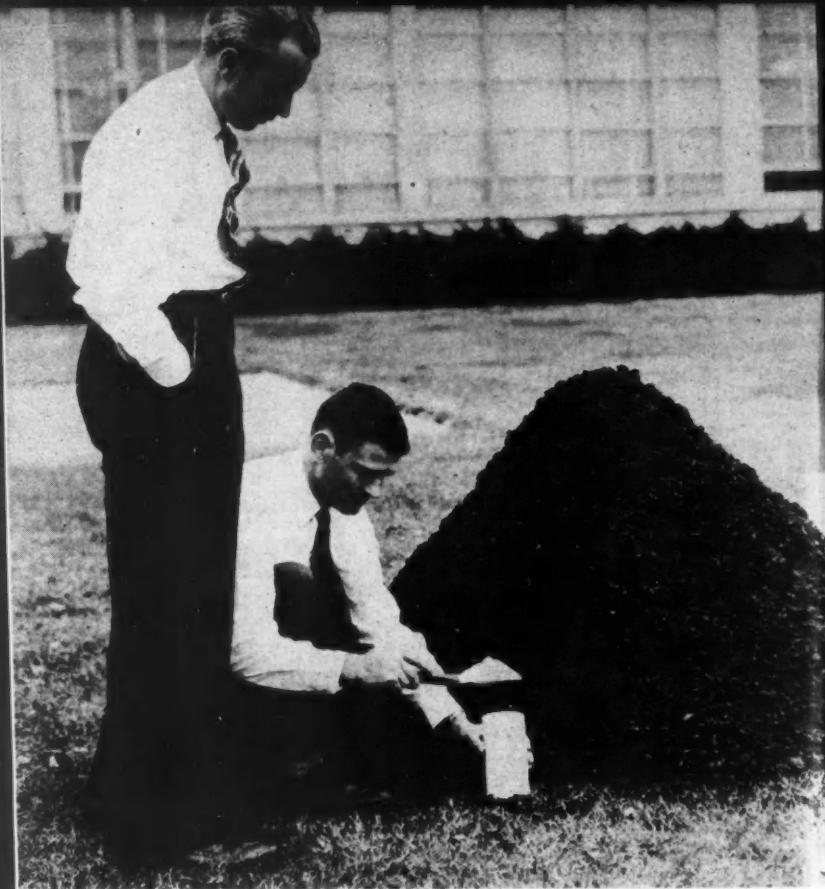
►DENSE, sticky clay, whose heavy clods break the necks of tender seedlings pushing their way up, is changed into crumbly-textured soil in minutes by working into it a small amount of a new chemical which has just been developed by the Monsanto Chemical Co.

Krilium, as the new material will be named for the market, is hydrolyzed polyacrylonitrile. The raw material, acrylonitrile, is manufactured from acetylene and hydrocyanic acid. Although it is a polymer, Krilium differs from the usual synthetic resins. It is a creamy white, water-soluble powder which behaves chemically as

a polyelectrolyte. Its large molecule has hundreds of points at which combinations are made with inorganic chemicals in the clay. This is the action which changes the structure of the clay, in the opinion of the Monsanto chemists. They speak of "soil aggregates" formed by Krilium, which keeps "crumbs" of soil from forming clods.

In spite of Krilium's combining power, its use does not change the alkalinity or acidity of the soil it modifies. Neither does it affect the nutrients present in the soil, nor the molds and bacteria which normally live there.

CHEMISTRY HALL LIBRARY



► CHEMISTS who developed Krilium, Dr. R. M. Hedrick and Dr. D. T. Moury, show the amount of Krilium, the white powder, needed to condition 100 square feet of garden, compared with the pile of peat moss necessary for the same purpose.



► VEGETATION holds the soil which has been treated with Krilium, as is pointed out by this student of the Ohio State University Civil Engineering Department, while erosion gullies form on the untreated part of the slope.

In fact, Krilium, because its action seems only to modify the physical characteristics of soil, allows research workers, for the first time, to distinguish between the effects of biological entities and the purely structural effects of various mulching agents which farmers habitually use.

Straw mulch, for example, is useful chiefly because it makes soil porous. Krilium-formed "crumbs" loosen the soil in the same way, resulting in better plant growth. Water can trickle down more readily to the plant roots, and air can reach them as well. Presence of air, research has shown, is essential to germination of seeds and to root growth. Young plants can drown in heavy soils when rain water is held in the cracks between the dense clods. Poinsettia roots, especially, need air and are very susceptible to such drowning.

Among other projects for its use, Krilium is being studied for erosion control. Two properties of soil treated with it work together for this purpose. The soil itself and the seeds are not washed out to so great an extent by the beating of the rain when its texture is loosened by the chemical's action. Also, the porous, spongy nature of the aggregated soil promotes rapid growth of cover vegetation planted to hold the soil in place.

Methods of applying Krilium to the soil are being tested. On some roadside cuts, a slurry of seeds, fertilizer and soil conditioner has been pumped together onto the steep banks, with promising results.

When the slurry so pumped happens to hit a rock outcrop, the dried material can afterward be seen as a shiny film on the surface of the rock. But this is not an impervious film. It

is capable of taking up moisture and passing it through to soil underneath. More water can be taken up and held by Krilium-treated soil without making mud than can be absorbed by the untreated soil.

Krilium came about because of the curiosity of two Monsanto executives. President Charles Allen Thomas and Vice President Carroll A. Hochwalt operated farms near Dayton, Ohio. They noticed that certain patches of soil in their fields did not yield as good crops as other parts of the same fields. There was no difference in the nutrients or the trace elements of the soils to account for the dissimilarity.

The two scientist-executives discussed a number of possible studies which could be made on the bare patches of soil, and asked their organization for the help of one chemist to try out some of their ideas. They cautioned him, however, not to spend too much time on the project.

Dr. Ross M. Hedrick was the first Monsanto chemist to work on the new soil conditioner. As the research progressed, he was joined by Dr. David T. Mowry. These two chemists then became the center of a research team.

When they got into studying the many aspects of the problem, however, the team realized how little work had been done on the engineering properties of soil, and further research possibilities opened up. The study was then taken up by Monsanto's Central Research Department, headed by Dr. Nicholas N. T. Samaras. He defines the problem in the following words:

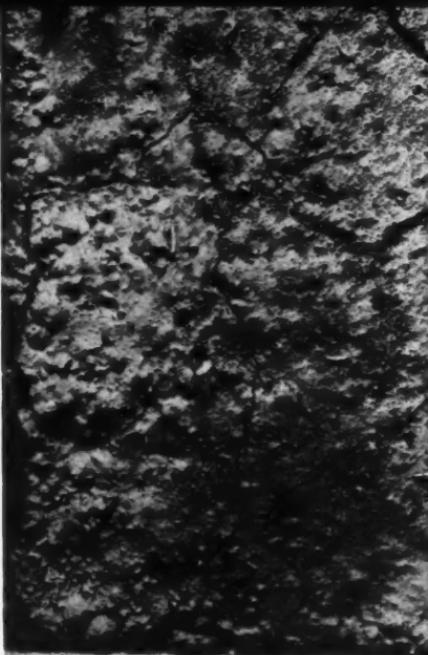
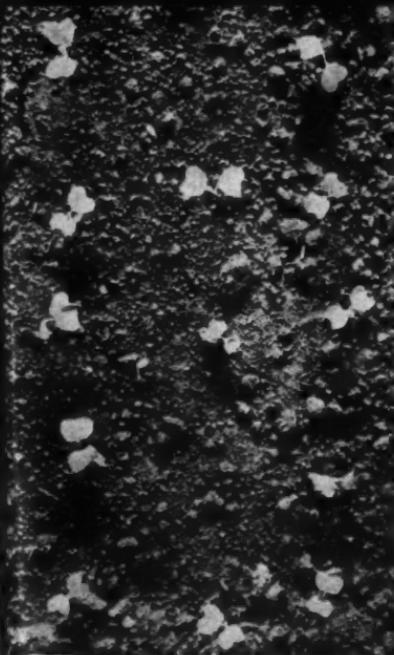
"The physical properties of a soil

are largely controlled by two factors, soil texture and soil structure. Soil texture is determined by the relative amounts of the ultimate particles of the soil, namely, sand, silt and clay. Soil structure, on the other hand, refers to the arrangement of these primary particles into relatively stable aggregates. In soil of good structure, these aggregates will range in size from that of a pinhead to that of a pea.

"The problem of maintaining soil in good structure is so important in agriculture that great trouble and expense are taken to rotate crops, to plow under crop residues and to add great quantities of manures, peat moss, compost and the like—and in many areas these are not obtainable.

"It had been found, in recent years, that certain natural gums of the polyuronide type are responsible for cementing together the primary particles of soil to form water-stable aggregates of the desired size, that is, to give soil of good structure. These naturally occurring conditions are formed as minor by-products when dead residues, manures, composts and the like are decomposed by soil micro-organisms.

"It takes many tons of manures or plant residues to produce one ton of polyuronides because most of the organic matter is decomposed to carbon dioxide and water. Furthermore, these polyuronides are themselves decomposed rapidly by other bacteria, so that it is necessary to keep adding large quantities of organic material in order to maintain a soil in good structure. Only a trace of the organic matter forms permanently insoluble soil humus, but the value of this insoluble



► SOIL which shrinks and dries to a hard crust after watering (right) shows a poor germination rate for radish seeds, while that treated with Krilium (left) gives the seedlings a better start.

fraction in soil structure is still debat-

"Our problem, thus, was to find synthetic chemicals which would have the same effect as the natural products but at much lower concentrations and be much more resistant to bacterial decomposition. We feel that we have succeeded in this search."

Monsanto chemists, in cooperation with agricultural experts at Ohio State University, have found that Krilium improves the workability of Ohio's clay soil. Fewer clods are formed when it is used. Plowing can be done earlier in the spring, with

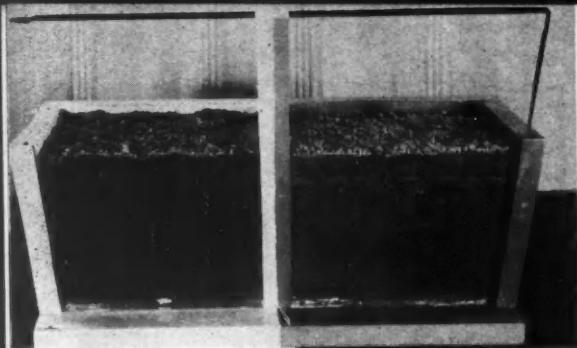
less cost for power and with im-

proved yields.

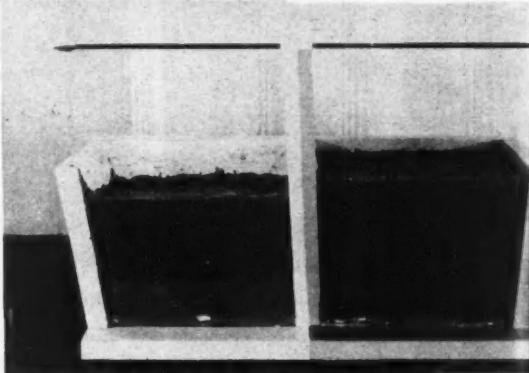
They are now engaged in similar research projects in different parts of the United States, in areas recommended by the U. S. Department of Agriculture as having "prob' em soils."

Some areas in the west have such a rating, where alkaline salts have accumulated and irrigation only makes conditions worse. Although the salts are soluble in water, the tight structure of the soil will not allow the water to drain away fast enough to leach them out.

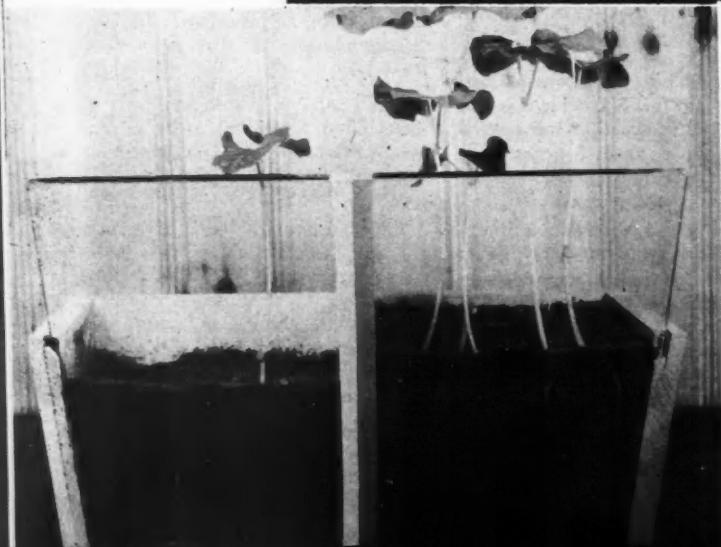
Along the coast in some southeast-



► In top picture, five beans are planted in each box. Soil on left is untreated, that on right has had Krilium added.



► Second picture shows comparative soil shrinkage when water is added. Krilium-treated soil remains porous.



► Five rising seedlings and their structure the treated soil are compared only one able to make its way through treated soil.

ern states there is a similar problem with encroaching sea water. This is not unlike the plight of Holland's flooded acres which must be reclaimed from the sea.

Even greenhouses have soil structure problems for, as the plants are watered, there is continuous and increasing shrinkage of the soil.

Monsanto chemists believe that, by working Krilium into problem soils such as these, drainage and aeration can be improved in such a way as to solve the difficulties. They also recommend mixing the new chemical with the subsoil turned up by bulldozers on housing projects. They claim it will save several years' work in developing lawns and gardens, beginning with the advantage that no weeds have gotten a start in the subsoil.

In garden soils of good natural structure, Krilium may not make a noticeable improvement. It is a conditioner for difficult ground. It can be applied along with fertilizer in preparation for planting. Its developers warn that it does not substitute for fertilizer, but that gardeners using it should be sure they provide enough

nutrients in the soil to take advantage of the better growing conditions Krilium provides for their plants.

Of course, as the soil is improved, it makes better growing conditions for the weeds, too. But Monsanto chemists smile and point out that they also manufacture chemicals to control weeds.

For gardening and truck farming, Krilium would compete with compost or peat moss. Its manufacturers consider one pound of Krilium equivalent in soil conditioning effectiveness to 200 lb. of peat moss or 500 lb. of compost.

They feel that for specialty crops, such as early vegetables, flowers and tobacco, its advantages will make a place for it promptly. They will have it in limited commercial production by spring of 1952, and in full production during the following year, at a retail price of less than two dollars a pound.

Although the stage of commercial production of Krilium is near, Monsanto chemists are still working with agricultural scientists in many parts of the country on research projects.

### *On the Back Cover*

► EROSION control on roadside cuts is the aim of this spray with which the Connecticut State Highway Department pumps seeds, fertilizer and soil conditioner together onto the steep bank. Krilium, the new soil conditioner, forms a filmy coating which helps hold the soil but lets moisture through, so that plants get a root hold. All photographs illustrating Krilium, except that on page 1, are from the Monsanto Chemical Co.

Some of these involve other chemical relatives of the new hydrolyzed polyacrylonitrile. Similar compounds which are more water-repellant are being tried for tennis courts, baseball diamonds and playgrounds.

In another kind of research, radioactive carbon 14 is being incorporated into the polyacrylonitrile molecule to

learn the ultimate fate of the conditioner in the soil. The tracer element is not expected to be taken up by plants growing in Krilium-treated earth. But the research workers are keeping watch to see what they can learn about soil in general, one of the commonest but least understood materials necessary for existence.

## *High Impact Resistance*

► A NEW STYRENE plastic, which has high resistance to blows and other impacts, is becoming widely used in refrigerators, replacing sheet metal. It probably will be widely used in water pipes and drainage systems, the American Society of Mechanical Engineers was told recently by Sanford E. Glick and C. H. Adams, Monsanto Chemical Company, Springfield, Mass.

The development of new and large injection molding equipment makes the future of this new class of thermoplastics bright, they stated. Future items to be produced with the present and anticipated materials will include plumbing fixtures, turrets and hoods, bread boxes, septic baths, gun mountings and office furniture.

Styrene is one of the hydrocarbons whose principal application has been, in recent years, in the manufacture of GR-S or Buna-S synthetic rubber. Styrene plastics have been in use for several years. This new high-impact sty-

rene is much tougher than general purpose styrene.

Many uses for a new class of materials, commercially processable rigid thermoplastic resin rubber blends, were described by E. S. Ebers, B. W. Bender and Thomas R. Grimes of the United States Rubber Company. These resin rubber blends, they stated, have toughness at good rigidity, are easily shaped into various forms, are stable dimensionally and have good chemical and stain resistance.

Applications range from use in television tube masks and refrigerator parts to crash padding and chemical piping where corrosion resistance is required. The material is available in various forms for various uses. It is called a versatile product because of its many uses. It can be processed by low cost methods such as simple forming tools, extrusion and injection molding.

Over 2,000 tons of aluminum are used in the construction of the new steamship United States; it is used for most exterior installations where strength and high corrosion resistance are required.

Some of the antibiotic so-called wonder drugs are successfully used to cause rapid growth in poultry and hogs and have them ready for the market two to six weeks earlier than otherwise.

## Crystal Clutch Joins Magnetic Fluid in Machines

# Chemical Machine Principles

► A NEW TYPE, high-speed clutch to transmit power from a rotating shaft to a drive shaft, as is done by the ordinary automobile clutch, utilizes a chemical product. Certain solid chemical crystals when excited by a direct current voltage, bend to bind the output disk on the drive shaft to the rotating input disk on the power shaft.

This clutch is the result of experimental development at the National Bureau of Standards by Ernest Codier. It is a part of a program for the development of fast-acting clutches suitable for use in high-speed computers. One model only has as yet been constructed. It is about six inches in diameter and a little more than an inch long.

Construction of this new so-called crystal clutch is relatively simple. The output disk is located between two rotating members, consisting of a thin flexible pressure plate and a heavier mounting plate, or input disk. The crystal elements, which bend when opposite potentials are applied to different parts of the crystal surfaces, are spaced at 120-degree intervals. When the exciting voltage is applied, the crystals press against the pressure plate at a radius of 1.5 inches, pinching the output disk between the pressure plate and the input disk.

The particular crystals used are what are known as bimorph piezo-

electric crystal elements. In the experimental unit Rochelle-salt crystal elements are used because they are readily available. These, however, are relatively unstable, and barium titanate crystals are regarded as a logical alternate.

Distinguishing features of the crystal clutch are high speed of response and almost negligible current drain. No current flows, other than insulation leakage, after the applied voltage has charged the capacity of the crystals. The clutch therefore creates no magnetic field, an advantage in some applications.

Applications for this new clutch may not be numerous. Yet its high speed and negligible current drain could be valuable in a few highly specialized but important instruments. One application might be, as an example, in photographic recording apparatus to move motion picture film in fast response to an activating voltage.

## New Magnetic Fluid

► NEW APPLICATIONS for the magnetic fluid used in clutches and brakes, announced by the National Bureau of Standards in 1948, were described in Portland, Oregon, recently to the American Institute of Electrical Engineers by Dwight B. Brede of the University of California division of electrical engineering.

He reported on investigations he had made on the use of a magnetic

fluid. This fluid is a mixture of finely divided iron and oil. It becomes practically a solid when it is between two steel plates as in an automobile clutch and the plates are made magnetic by use of an electric current. It then holds the plates in a unit. When the magnetizing current is cut the iron particles lose their magnetism and the mixture becomes a fluid again.

Several scientists in the country are making investigations to determine the best types of oil and of iron to use in magnetic fluids for various uses. Mr. Brede reported that a mixture of seven parts of a particular carbonyl

with one part of a silicone oil provides a magnetic fluid of low residual torque and high magnetic fluid torque.

A magnetic fluid dynamometer is definitely feasible and can be a useful engineering tool, he said. A dynamometer is used to measure the torque of a machine in order to determine its power output. The smoothness of control and the possibility of simple water cooling made the use of a magnetic fluid dynamometer attractive, he said, particularly where load tests on large motors are being made.

### *Rancher's Gift to Improve Arid Regions*

► WITH THE ultimate aim of making the world's arid regions more productive, the University of California has announced the establishment of the M. Theodore Kearney Foundation of Soil Science in its College of Agriculture.

The foundation will be devoted to the advancement of knowledge of soil science, including soil-water-plant relations, through basic physical, chemical, biological and hydrological research, with particular reference to arid and semi-arid farming regions.

The new foundation will be endowed with the proceeds of the bequest of Mr. Kearney, prominent rancher in central California in the latter part of the last century, who died in 1906, leaving to the University his estate which included the famous Kearney Vineyard in Fresno County. The endowment now amounts to \$2,268,000.

One-third of the total land area of

the world is arid or semi-arid. Less is known about the soils in these regions than about those in the more humid areas, where farming and agricultural research have flourished.

Population increases and improved agricultural practices, however, are bringing more and more marginal land into production—establishing a need for more knowledge about soils.

Studies conducted by the new foundation will benefit California, the western one-third of continental United States, and a large portion of the world where desert and semi-desert conditions exist.

The Kearney Foundation will be administered by a director within the present framework of the University of California's College of Agriculture. Eventually additional outstanding scientists will be added to round out a well-balanced staff and program of soil investigations.

## Matter in Unusual Forms Detected by Astronomy

# Strange Chemistry in the Heavens

► DISCOVERY that hearts of atoms heavier than any previously observed are bombarding the earth from outer space was reported to the American Physical Society recently by Dr. Herman Yagoda of the National Institutes of Health, Bethesda, Md.

Cosmic rays particles consisting of charged nuclei as massive as copper, bromine and even tin are contained in the stream of radiation arriving in the stratosphere. While most of the cosmic radiation consists of protons, which are hydrogen atomic nuclei of tremendous energies, teams of physicists from the University of Minnesota and the University of Rochester about two years ago discovered they are accompanied by equally energetic heavy atoms of carbon, silicon, calcium and iron. Now Dr. Yagoda from new experiments with photographic emulsions carried to 110,000-foot elevations by giant plastic balloons has found even heavier atoms.

Emulsions about a hundred times thicker than on ordinary plates were used to capture the heavy atoms.

### Protons and the Aurora

► EXPLANATION of the aurora and new information on what happens to atomic fission fragments are expected to result from experiments reported to the American Physical Society by Dr. S. K. Allison of the University of Chicago.

Beams of hydrogen atom hearts, or protons, from a high energy accelera-

tor were studied by Dr. Allison when they shot out into the air.

The protons eventually become slowed down, capturing electrons, the negative electrical particle, from the molecules of the air. This makes them become ordinary hydrogen atoms and they are indistinguishable from the minute amount of hydrogen already present in the atmosphere.

Dr. Allison found that this picking up of electrons by the protons is a fluctuating process. An electron is picked up by a fairly fast proton, moves with it for a while and then is scraped off. After some time, the proton again captures an electron which, since the proton is now slower, stays on for a longer time. Eventually the proton moves so slowly that a captured electron is permanently retained.

Such captures and losses are extremely prominent in the slowing down of fission fragments and the experiments on atomic beams are expected to give basic information in understanding this important atomic action.

The light of the aurora or northern lights may be emitted when protons ejected by the sun begin to capture electrons as they slow down in the earth's atmosphere. For this reason, Dr. Allison's experiments may help us understand these displays in the night sky.

### New White Dwarf Stars

► FORTY-FOUR new white dwarf stars in the southern skies have been reported by Dr. Willem J. Luyten of the University of Minnesota. This brings to almost 150 the total number of known white dwarfs, small stars with intensely hot surfaces.

These peculiar stars are noted for their great density. A cubic inch of one of them, if brought down to earth, might weigh anywhere from one to a thousand tons.

These stars are genuine dwarfs in every respect. Some are as small as our moon. They give off relatively little light, which makes them hard to find. It would take about 10,000 of the average white dwarfs to give off as much light as our sun. They shine with a light much whiter than that of the sun, and often even blue in color.

The stars were found by observing, on plates borrowed from Harvard Observatory, the color of some 16,000 stars that seemed to move around in the heavens more than their neighbors. Most of the stars were red, but

some 800 were singled out as definitely bluer than expected. Further study indicated that 44 were probably white dwarfs.

The first of these stars ever discovered was found because of little erratic shifts in the motion of Sirius, the brightest star in the sky. The shifts were accounted for when Sirius was found to be accompanied by a "dark companion," a very strange kind of star.

This different kind of star is so small that it is only a little larger than the earth. In volume, it is 40,000 times smaller than the sun, yet within that small space is packed just as much matter as there is in the sun itself. This makes the star so dense one cubic inch would weigh about 2,500 times as much as gold.

In these stars astronomers are dealing with matter in the raw. Heated to terrific temperatures, perhaps billions of degrees, all the atoms are "stripped" of their protective covering of electrons. This makes the atoms so much smaller it is possible to "pack" them much closer.

### Rare Earth Stand-ins

► HOW MAN-MADE elements such as berkelium and californium will react with other chemicals can be predicted more accurately by using rare earths as "stand-ins."

Only very minute amounts of man-made elements are formed by cyclotron bombardment or by fission chain reaction. But their atomic structure is similar to the rare earths, so scientists are studying these stand-in elements instead.

Drs. Clifford S. Garner and Dale Meier of the University of California at Los Angeles have just completed studies with europium, rarest of the rare earths. Rare earths are so called because, although they are abundantly present in the earth's crust, it is very difficult to separate one from the other. The chemists were studying how doubly charged europium atoms can become triply charged ones and vice versa.

Up-to-Date Information  
For Civil Defense Use

## If We Are Bombed

► CIVIL DEFENSE planning should take into account the dangers of heat and carbon monoxide poisoning which will come if we are attacked by atom bombs, Dr. Cortez F. Enloe, Jr., of New York, warns in a report in the *Journal of the American Medical Association*.

Dr. Enloe was chief of the medical science branch, U. S. Strategic Bombing Survey, which studied the effects of bombing on German health and medical care at the end of World War II. He was recently awarded the Legion of Merit for his work in this capacity.

The effects of high explosive and fire-bomb raids on individuals in German cities was not much different from the effects of the atom bombs on individuals in Hiroshima and Nagasaki, excluding the radiation effects. The radiation effects accounted for about one-fifth of the casualties in the Japanese cities.

In a high explosive raid, the type carried out on European cities and the type to which this country is apparently immune, mechanical injuries would outnumber deaths. But in an atomic bomb attack, Dr. Enloe states, it is expected that the effects of heat and carbon monoxide would cause more deaths than injuries.

By heat deaths is meant death from the high temperatures, not death from burns.

Heat stroke, he points out, caused

the death of many Germans in rooms from which they could have escaped.

Temperatures in Hamburg, during one of the fire raids, according to police estimates, went as high as 1,472 degrees Fahrenheit in the burning city blocks. The temperature of boiling water is 212 degrees Fahrenheit, that of the normal human body 98.6 degrees.

In this same city, it is estimated that 70 per cent of all casualties not resulting from mechanical injury or burns were caused by carbon monoxide gas, Dr. Enloe states.

Carbon monoxide casualties may always be expected in flaming buildings where exits have been blocked by rubble, indicating the imperative need for adequate exits, he warns. One cannot glibly endorse the general attitude that the basement of every dwelling affords relative safety. It may afford safety from blast, but if the building catches fire, and, as we have said, fire is the main cause of atomic bomb damage, the cellar becomes but a tomb.

Some persons may be expected to "drown in dust" because of dust blockage of their noses and throats in the raid.

Drowning in water is a danger in shelters and basements if water mains are broken and buildings collapse.

Establishment of psychiatric first-aid stations, Dr. Enloe declares, is sound in theory but experience has shown that it is a waste of time. Con-

trary to expectation, air attacks on the civilian population do not increase the amount of psychiatric disorders.

### No Atom Bomb Surge in U.S.

► THE DREADED "base surge" which spread out from the Bikini underwater A-bomb explosion will not occur in temperate climates.

Speculations that a base surge could inundate New York City and leave in its wake very appreciable radioactive contamination are unfounded from a meteorological standpoint, Air Force Col. B. G. Holzman reports in the *American Meteorological Society Bulletin*.

To an observer ten miles away, Col. Holzman says, the base surge was indeed a frightening and almost cataclysmic spectacle. The surge, instead of diminishing with time and travel-distance, increased in horizontal extent to many thousands of feet and reached a height of several thousand feet.

But a duplication of this base surge

in New York harbor might be difficult if not impossible to accomplish.

Col. Holzman explains that the base surge was dependent on the very moist tropical air mass prevailing at the time of the explosion. The surge acted as a meteorological cold front, pushing the moisture-laden surrounding air up. This moisture then condensed, adding to the height and volume of the surge.

The important point is, Col. Holzman believes, that the moisture in the surge in its later stages did not rise from the lagoon but was already in the air at the time of the explosion and, therefore, had little radioactive contamination.

The severest radioactive contamination is associated with the initially-ejected water in the familiar cylindrical column, around which the surge forms, and the plume. The contaminated rain from this source is of greatest significance in the problem of civilian defense.

## Radiations Set Stage for Life

► EVIDENCE that atomic radiations bombarding the earth in the early stages of the earth's history could have set the stage for the origin of life has been obtained in cyclotron atomic energy experiments.

A team of University of California scientists exposed carbon dioxide water solutions to 40,000,000 electron volt helium ion beams from the 60-inch cyclotron. They found that it is possible to "reduce appreciable quantities of carbon dioxide to formic acid by means of water through the agency of radiation."

This means that before there was any life organic matter could be created. Since one popular and plausible theory is that life originated in the beginning in organic matter, this discovery reinforces this idea.

Radioactively labeled carbon isotope 14 was used in the tests. Formaldehyde as well as formic acid, which are primary organic chemicals, were formed in the tests, but by just what chemical path is yet to be determined.

Drs. W. M. Garrison, D. C. Morrison, J. G. Hamilton, A. A. Benson and M. Calvin were the scientific team reporting to the journal *Science*.

Address on Ninth Anniversary  
Of Atomic Energy Achievement

## Atomic Energy for Peace

by GORDON DEAN

Chairman United States Energy Commission

*Extracts from an address to the Annual Dinner of the Alumni Association of the City College of New York, Dec. 8, 1951.*

► I THINK it might well be profitable for us to examine for a moment just what we have here in our newly-found ability to unlock the treasurehouse which is the nucleus of an atom. Essentially, we have a whole new source of energy to serve mankind. Prior to 1942, virtually all of the energy usable by man was energy that had originally come from nuclear reactions in the sun and had been stored gradually in various organic carbon compounds here on earth over a course of many millions of years.

The process by which the sun's energy is captured and stored on earth is known as photosynthesis—the vitally important and still mysterious phenomenon by which green plants take carbon dioxide, water and sunlight and produce energy-rich carbohydrates, proteins and fats. It is this process which has provided man with his food, his fuel and his oxygen. It provides him with his food because the plant tissue produced by photosynthesis is the ultimate source of nourishment for all of the plants, marine life and animals on earth. It provides him with fuel because it produces the world's forests and because the earth's resources of coal and petroleum come from plant tissues created

ages ago by photosynthesis. The oxygen man breathes is a byproduct of this same process.

In the comparatively recent past, man has learned how to exploit in furnaces and engines the energy stored in the coal and petroleum resources of the earth and he has devoted a good deal of his attention to learning how to do this most effectively. He of course has been extremely successful, and the measure of his success has very largely determined the high standard of living enjoyed in many parts of the world. As a matter of fact, so successful has man been in his efforts to exploit his resources of coal and petroleum that we are today consuming our reserves of these fuels at a rate many millions of times greater than the rate at which nature produces them. In other words, we are working ourselves toward the day when, inevitably, we are going to run out of our principal traditional sources of energy.

There are, of course, a number of possible solutions to this problem:

One: Man might, assuming he could, harness the energy that comes from the sun directly, by some mechanical means, without waiting for nature to store it up for him in the form of chemical energy in organic compounds.

Two: He might, assuming he could, duplicate nature's process of

photosynthesis artificially and speed it up to the point where the rate at which chemical energy is stored equals the rate at which man consumes it.

Or three: He might find an entirely new source of energy, independent of the sun, such as, for example, the process used by the sun itself—the nuclear reaction.

### Nuclear Energy Achieved

Of these possibilities, man in 1942 in the squash court at Stagg Field in Chicago achieved one—the third. He proved that it was possible here on earth to release and control the energy stored in the nuclei of atoms, and, by doing so, he increased enormously the potential sources of energy to which he has access. That, in essence, is the significance of the atomic age.

This accomplishment in 1942 suggested a number of new lines of research that would have to be followed if the full promise of atomic energy were ever to be realized. One of the more important of these has the objective of increasing the supply of materials that can be made to release their nuclear energy. Perhaps the most significant basic limitation in the whole atomic energy field is the fact that of all the substances on earth, only one small fraction of one naturally-occurring element—uranium—can, on the basis of current knowledge, be made to release its nuclear energy. This material is the uranium isotope numbered 235, which comprises less than one percent of the metal uranium as it occurs in nature. Economically recoverable concentrations of uranium are, as you know, rare, and if only one percent or less of this material could ever be used for atomic energy purposes, the signifi-

cance of this new source of energy would be severely limited.

It so happens, however, that in addition to the natural uranium isotope 235, there are also two other materials—both artificially created—that can be made to support a self-sustaining, energy-releasing nuclear reaction. One of these is plutonium, which is made from that part of uranium which does not directly release nuclear energy. The second is the uranium isotope 233, which is made from the naturally-occurring element thorium.

These three substances—plutonium, uranium-233 and uranium-235—are known as fissionable materials. You might think that, inasmuch as we can make fissionable material out of uranium and thorium, we should be able to transform all of the uranium and thorium in the earth into fissionable material. But, on the basis of our present knowledge, we cannot make fissionable material without using up fissionable material in the process, and at present the only process we have uses up more fissionable material than it produces. You can see that, although all the uranium and thorium in the earth is potentially useful as a source of atomic energy, we are fundamentally limited in our efforts to convert it to useful form.

### Breeder Reaction

If, however, we can develop a process which will produce more fissionable material than it consumes, we will have broken out of this fundamental limitation and will have pointed ourselves in a direction where we may hope ultimately to use every last scrap of uranium and thorium that can be found and taken out of the earth. The significance of this possibility becomes

apparent, I believe, when we recall that it has been reliably estimated that there is more than ten times as much energy contained in the economically recoverable uranium deposits of the earth than there is in all of the economically recoverable coal and petroleum deposits combined. This, incidentally, does not take thorium into account, and thorium is almost as prevalent as uranium.

This, then, is one of the lines of research suggested by man's mastery of the technique of releasing nuclear energy. It is a significant line of research, and I am pleased to report that it is being pursued vigorously and with encouraging results. The process involved—called the breeding process—has been worked out in theory, and a machine designed to test it has been built at our Reactor Testing Station in Idaho where it is now undergoing the tests which are part of the start-up operation. Although it may be some time before we will know whether this machine will demonstrate the feasibility of breeding, we have every hope that it will.

### Mobile Reactors

Another line of research suggested by the 1942 experiment in Chicago is the development of machines in which the fissionable materials I have mentioned can be made to react to produce power to do man's work. At present, two general types of such machines—called nuclear reactors—are envisioned: relatively small, mobile ones to propel vehicles of transportation; and large, stationary ones to produce central-station electrical power. I am pleased to report that this work, too, is going forward. In the mobile reactor field, we now have under con-

struction in Idaho a land-based prototype of a reactor suitable for submarine propulsion, and we have another, somewhat similar machine in the design stage. We also have under development a reactor suitable for the propulsion of a military aircraft.

It might be said, of course, that submarines and military airplanes are hardly instruments of peace, but I think it is evident that if we can build a reactor to propel a submarine we can build one to propel a merchant vessel, and if we can build a reactor to propel a military aircraft, we can build one to propel a commercial plane. In the world as it is today, there is a clear and urgent need for reactors for military use regardless of cost, so what we are doing, in effect, is charging the high developmental costs of these machines against the national security, and they will be used first for that purpose. But this does not mean they will be any less effective for peaceful application. I think it is also worth noting in this connection that insofar as atomic energy is used by the military services for their propulsion needs, coal and oil can be released to the civilian economy.

In the case of large, stationary atomic power plants, progress is also being made, although perhaps not quite so rapidly as in the field of small, mobile reactors. This is partly because the energy released in a nuclear reactor appears in the form of heat, and at present the only way in which this energy can be utilized is to take the heat out of the reactor and put it to some such useful work as turning a turbine to produce electricity. In a large central-station power plant, great quantities of power must be produced

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to make the installation worthwhile, and in order to produce great quantities of power, very high temperatures must be attained. This, in turn, means that very high degrees of nuclear radiation must be reached within the reactor.

### Unpredictable Materials

It is here that we encounter a serious difficulty, for most of the materials we are used to working with in other fields react in strange and frequently unpredictable ways when they are subjected to very high temperatures in combination with very high levels of nuclear radiation. What we must do, then, is to go through an intermediate stage in our development of atomic power, and that is to build a device in which we can test the materials we hope to use and to test them under the conditions that will be found in a real power-producing plant. I am glad to report to you that we are now building such a device at our testing station in Idaho. It is called a materials testing reactor, and it will produce higher levels of temperature and radiation than any atomic energy machine yet built. We expect it to help us significantly in our efforts to advance toward the day when we will have power in useful quantities from atomic energy.

There are also a number of other reactors under development or construction, or recently completed, which are helping us toward this goal. One I might mention in particular. It is the one we have recently built in Idaho to test the breeding process. This same reactor has been designed also to produce power experimentally. It will not produce very much power,

and it is not what we could honestly call a power reactor, but it is expected to produce some useful power, and, if it does, it will be the first of our reactors to do so. If everything goes the way we expect it to, we should see this reactor produce its first power sometime in the first half of next year.\*

The real, full-scale, power-producing reactor of the future will probably be one of this same general type—that is, it will be designed both to breed nuclear fuel and to produce power, thus simultaneously releasing energy while producing new sources of energy. If this can be achieved, practically the only material going to waste in the reactor system will be the "ashes" of the nuclear fission process. But these "ashes" are highly radioactive, which means that they too are releasing energy, and in a really efficient system this radiant energy should also be put to some kind of useful work. At present it is not used at all, except in extremely small quantities for special kinds of research.

### Uses for Wastes

The Commission is very interested in finding uses for these highly radioactive waste materials, and to this end we recently asked a private research organization—the Stanford Research Institute of Stanford, California—to make a study of their possible uses and the potential industrial demand for them. This group has just submitted its report, and it finds that there would be a potentially large demand for these products if they can do the things it has been said they can do.

We can gain some idea of what

\* Success in producing the first self-sustaining reaction of this kind was announced by the A. E. C. as the year 1951 closed.—ED.

they might do by examining their capabilities. First, they have the capability of killing organisms, which means they might be used to sterilize foods and drugs without the use of heat, if some way can be found to accomplish this without causing harmful changes in the materials treated. The facts about this are now being established by experiment. Second, they have the capability of inducing chemical reactions, which means they might be used to produce new or cheaper chemicals. Third, they can ionize gases, which means they might be useful in producing improved static eliminators or more efficient fluorescent lights. Other potential uses suggested are the production of new types of luminescent paints and the making of photographs through solids. You may be assured that the Commission will push vigorously the development of ways in which these products can be made available to industry for the betterment of man's welfare. This is one place where we hope private enterprise will step into the atomic energy picture on its own. We believe that uses for these radioactive "ashes" can be worked out to the profit of industry, and we hope and expect that more and more firms will send their own scientific exploring expeditions into this new frontier. Some already are.

There were, of course, many other lines of research opened up by the birth of the atomic age. One of the principal ones was the development of ways to utilize nuclear energy to produce particular kinds of radioactive materials for use in medicine, science, agriculture and industry. These are the materials known as radioisotopes, and it is this field that to date

has produced by far the most concrete results in the peaceful application of atomic energy. Most radioisotopes are made by subjecting ordinary forms of such elements as sodium, phosphorus or iodine to the intense radiations produced in a nuclear reactor. These materials in turn become radioactive and send out radiations that can penetrate solid materials and can be detected by means of special instruments such as the Geiger counter. This means that they can be used to trace biological and chemical processes which heretofore could not be observed, and thus they are of very great value in medical, industrial and agricultural research. These same radiations can also kill cells and cause mutations, which means they can be used to destroy diseased tissues and to assist in the breeding of new types of plants and animals.

### Research Projects

There are many hundreds of specific uses to which the radioisotopes produced in the Atomic Energy Commission's reactor at Oak Ridge are being put, and one could talk for many hours on the contributions they are making to medicine, agriculture and industry. I would like to go into these in some detail, but in the interest of time I have more or less arbitrarily selected six applications which I believe illustrate the diversity of the uses to which radioisotopes can be put. These are:

1. To study the action of fertilizers in plant growth, and thus to develop for farmers ways of getting more plant production out of the tens of millions of dollars annually spent for fertilizers.
2. To study the habits and charac-

teristics of such pests as mosquitoes, and thus to assist in bringing them under control.

3. To study the friction process, and thus to assist in the development of better rubber tires, engine lubricants, and the like.

4. To study the reactions by which gasoline can be produced synthetically from coal or natural gas, and thus to assist in increasing the yields of this process.

5. To study the ways in which hormones, amino acids, vitamins and drugs exert their influence on the body, and thus to assist in developing ways to control the body's use of these substances in the interest of better health.

And 6. To treat directly certain types of diseases, such as hyperthyroidism, the blood disease polycythemia, and—as a palliative treatment mainly—some kinds of cancer.

These, as I have said, are but a few isolated examples of the uses that are being made of radioisotopes in hospitals, industrial concerns, scientific laboratories and agricultural experiment stations all over the country and, to some extent, the world. The Commission is interested in increasing this utilization of radioisotopes as much as possible, and to this end sells isotopes at cost or less, supports a training center at Oak Ridge where investigators are taught isotopic research techniques, and encourages the participation of private industry in the business of packaging and distributing isotopes and in synthesizing them into compounds that are most useful to research investigators and industry.

These lines of peacetime research which I have mentioned this evening

are those that were immediately opened up by man's mastery of the technique of releasing the energy contained in atomic nuclei, and which have been pushed most vigorously. In addition, there are in the atomic energy field many other broad lines of research whose objectives stand as challenges to the most capable and imaginative of the world's scientists. Of these, I might mention:

1. The possibility—however remote—that someday someone may find a way to transfer atomic energy directly into electrical energy without going through the process whereby heat must first be produced and then utilized.

2. The possibility—however remote—that someday someone may find a way to make naturally-occurring elements other than uranium and thorium give up the energy stored in their atomic nuclei.

And 3. The possibility that the research tools and knowledge developed in the atomic energy field can be brought to bear upon and can be made to help solve the problem of harnessing directly the sun's energy and of putting it to work for mankind here on earth.

### Photosynthesis

In regard to this last possibility, I think it is worth noting that atomic energy has already supplied scientists with one of their most valuable research tools in the effort to solve the mysteries of photosynthesis. Man has long been intrigued by this problem, and he has developed an intense interest in solving it, for, if he can do so, he will have found the means by which he may create virtually unlimited supplies of both food and fuel, and he will have won his indepen-

dence from the natural resources which are now so rapidly being depleted.

The tool which atomic energy has supplied for this research is radioactive carbon. Before this material became available in large quantities through atomic energy, scientists were almost literally working in the dark, for although they knew plant tissues took in carbon dioxide, water and sunlight, and somehow produced energy-rich materials from them, they had practically no idea of what went on in between, or, for that matter, any really effective means of finding out. Since carbon is the key element in the entire process of photosynthesis, however, and since radioactive carbon behaves in the same way as ordinary carbon except for the radiations it emits, it has become possible through the use of radioactive carbon to trace many of the reactions that are a part of photosynthesis. In the words of one leading scientist, Dr. Melvin Calvin of the University of California, "It was as though the scientists had been given an eye which could look into the plant cells and which could see the actual processes taking place."

I would like to think that through our production of radioactive carbon, and through our partial support of the research being carried on in the field of photosynthesis—the AEC currently puts something like \$200,000 a year into this kind of work—the atomic energy program will be at least partly responsible for the ultimate solution of this problem.

I would like to think, too, that our efforts to find reactor materials that will withstand very high temperatures and very high levels of radiation might

help somewhat in the ultimate solution of the many problems involved in collecting and concentrating mechanically the energy which comes to us from the sun, and of transforming this energy into useful power.

In our day-to-day efforts to administer the United States atomic energy program, there is one extremely important factor we try never to forget, and this is the factor called basic research. Today we make our estimates and guesses and plot our course on the basis of things we know, and from this vantage point we can see only so far into the future. What is beyond our limited horizon no one can tell. Nine years after Benjamin Franklin sent his now-famous kite into the air, how many people were able to predict our modern utilization of electricity? Not many, and this is the position we are in today in atomic energy. What the future holds we do not know, but we can attempt to find out, and this we are trying to do in the great atomic research centers and in the universities and private laboratories located all over the country.

In a sense, we have recently entered a room, the door to which was labeled the atomic age. We are in that room and we have found that it is so large and so dimly lighted that we cannot begin to perceive its size or to recognize what is in it. But we have crossed the threshold and we cannot turn back. All we can do is to go forward as boldly—yet as wisely—as we can. I think one of the great responsibilities we in the United States assumed when we gained our current position of atomic world leadership was to lead the way into the atomic age. To do it

well, we will need all the guidance we can obtain from those of us who have had the privilege of being educated in America's great universities — people like yourselves. I sincerely hope that you — as American citizens and responsible citizens of the world — will

take an interest in atomic energy and will do all within your capability and power to help bring to fulfillment the dreams that must have been in the minds of those who first unlocked the treasurehouse which is the nucleus of an atom.

### *Manganese Method Needed*

► GREATLY increased production of domestic manganese, essential in steel making, is important to enable the nation to be self-sufficient in this basic metal. America has plentiful manganese ore but it is low-grade. Every ton of steel made requires about 13 pounds of manganese. Only about 10% of the amount now used is produced in the United States.

America's present supply of man-

ganese comes largely from India, Africa and Brazil. A decade ago it came from the Soviet Union but this source of supply is now practically closed. Great deposits of manganese-bearing formations are found in Minnesota's Cuyuna Iron Range. However, the ore has little practical value until a commercial method of reducing it has been developed.

### *Artificial Fur of Synthetic Fiber*

► ARTIFICIAL FUR, suitable for use in Arctic clothing for men in the armed services, is in experimental use at the Wright-Patterson Air Force Base, Daytona, Ohio. Two types are in use. One is to replace wolf fur, the other is a substitute for mouton from sheep. Both are inexpensive.

The principal use of these furs in the Air Force is in trimming and lining parka hoods, flight jackets and caps for Arctic operations. Strips of wolf fur, used because its long, smooth-fibered guard hairs enable frost formed by breathing to be easily knocked off, is a satisfactory material. But wolf fur is no longer available in sufficient quantities.

The new synthetic wolf fur, still in an experimental stage, is made of nylon fiber on a backing of knit cotton coated with rubber. As nylon is a poor

conductor of heat, the parka wearer's face stays warm. As it does not absorb moisture readily, frost is easy to brush off.

Since sheep are scarce too, the Air Force is experimenting with synthetic mouton made from a blend of two synthetic textile fibers, Dynel and Vicara. Like artificial wolf fur, this synthetic mouton will prove much cheaper than the real material. It will be used for collar trimming on flight jackets and hoods.

Both products rival their natural counterparts in luster, softness, quality and wearability. They are easy to work with and, unlike natural furs which must be sewed together, can be cut in any desired shape or form. These synthetic furs are made by the George W. Borg Corporation, Delavan, Wis.

## New Dirac Theory Revives Old Concept

# New Electrodynamics Needs Ether

► WE MUST have an ether, after all.

The idea of a universal and all-pervading fluid was abandoned shortly after Einstein's discovery in 1905 of the principle of relativity, into which an ether could not be fitted.

Now a Nobelist in physics who has done much to build the theoretical world of physics as we know it, Dr. P. A. M. Dirac of St. John's College, Cambridge University, England, as the result of his new theory of electrodynamics, concludes that "with the new theory of electrodynamics we are rather forced to have an ether." The new Dirac electrodynamics theory has not yet been published but the Royal Society has it in press.

This rejuvenation of ether is sure to stir great interest.

The theory is set forth in a letter to the British journal, *Nature*, published in London.

Dr. Dirac has applied quantum mechanics, the mathematical concept of physics that won for him the 1933 Nobel prize, to the ether.

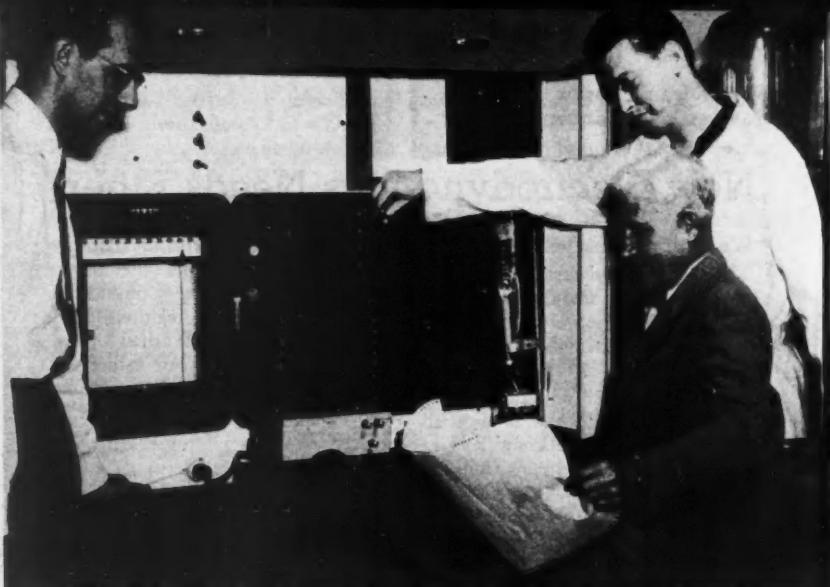
In the last century the ether seemed necessary to explain how light and electromagnetic radiation operated. It was supposed to be in perfect vacuum everywhere. The ether at each point in empty space was supposed to have a velocity less than that of light and the directional effect should have been detected by experiment. Relativity contradicted this, since all directions were required to be equivalent.

Now Dr. Dirac explains that the velocity of the ether, like other physical variables in the new physics, is subject to uncertainty relations. It is possible to set up what is called a wave function which makes all values for the velocity of ether equally probable. This could represent the perfect vacuum that would fit into relativity.

We may very well have an ether, subject to quantum mechanics and conforming to relativity, provided we are willing to consider the perfect vacuum as an idealized state, not attainable in practice, Dr. Dirac declares. From the experimental point of view, there does not seem to be any objection to this. We must make some profound alterations in our theoretical ideas of the vacuum. It is no longer a trivial state, but needs elaborate mathematics for its description.

Dr. Dirac's new electrodynamics theory derives a velocity with which any electric charge must flow. In regions where there is no charge it is the velocity with which a small charge would have to flow if it were introduced.

This velocity which is the same at all points in space-time plays a fundamental part in electrodynamics, that is, almost the whole physical world around us. Since it is natural to consider this the velocity of some physical thing, the ether, long abandoned, is now reborn.



► PROF. DUNN and graduate students Deutsch and Zuckerman study data recorded by new instrument.

## Analysis by Spectrophotometer

► A NEW electronic analyzer, developed by Alfred Deutsch and Richard Zuckerman, graduate students in chemistry at the University of California at Los Angeles, does several years work in a matter of weeks. It is expected to be useful in chemical and drug laboratories, food processing plants, hospitals and other laboratories where research is done.

Known as a "continuous flow recording ultra-violet spectrophotometer," the device can analyze any solution capable of absorbing ultra-violet light. In addition, it determines the purity of substances in solution and separates out pure fractions or parts of a solution.

Designed and built under the supervision of Dr. Max S. Dunn, professor of chemistry, the instrument can record absorption continuously at four pre-set ultraviolet wavelengths.

The solution passes over a resin which allows the various ions to be adsorbed along its course. Some ions cling tighter than others. A dilute wash is then introduced over the resin which carries with it a certain group of these ions.

As this passes through the spectrophotometer, the adsorption volumes are tape recorded and the solution flows into a collecting bottle, either separately or with other substances, as the operator desires.

Hottest Flame, Almost Solar,  
From Hydrogen and Fluorine

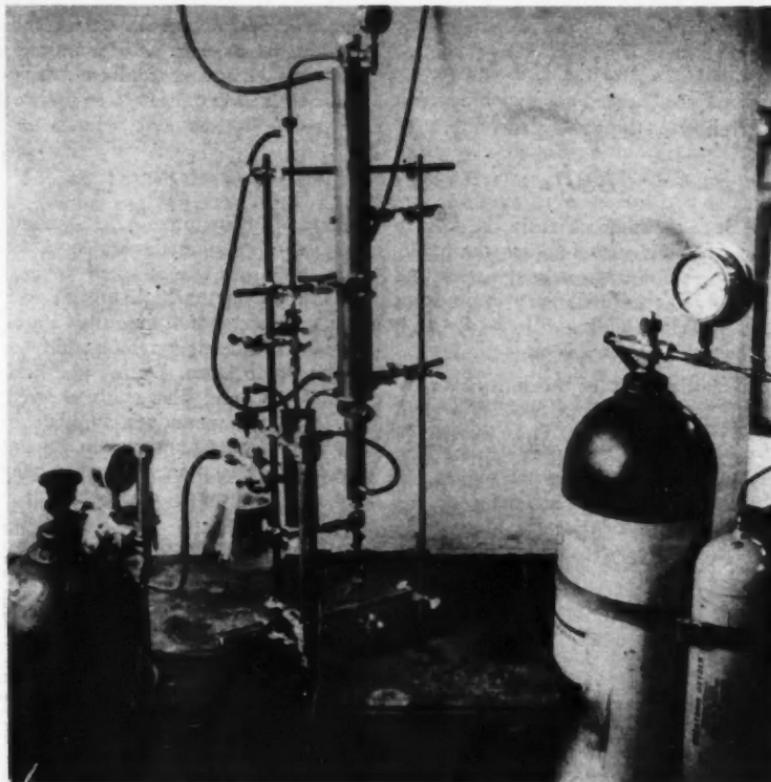
## Fluorine Torch Near Sun's Heat

► THE HOTTEST flame that man has ever created, fluorine burning in hydrogen, at 8,000 degrees Fahrenheit was described by Dr. A. V. Grosse of Temple University's Research Institute at a meeting celebrating the Na-

tional Bureau of Standards' 50th Anniversary.

Comparing the flame directly with the sun, Dr. Grosse and his team found that at ordinary atmospheric pressure the temperature was 7,000

► HYDROGEN and fluorine burn in this torch with hottest flame yet observed.



degrees Fahrenheit (4,300 K.) which increased to 8,000 degrees Fahrenheit (4,750 K.) when under five atmospheres pressure. The sun temperature is 9,000 degrees Fahrenheit and with higher pressures the Temple University scientists expect to reach sun temperature on earth.

The oxy-aluminum torch in previous Temple experiments had been able to melt anything against which it was directed, but the even higher temperature of the hydrogen-fluorine torch will likewise melt everything so far known on earth.

The sun and the H-F flame were directly compared by matching their brightness through glass filters by

what is known as the line reversal method.

A heliostat that had lain dust-covered and unused at Bryn Mawr College was used by Dr. R. H. Wilson, Jr., Temple University astronomer, to bring the sunlight to the laboratory for comparison.

Dr. J. B. Conway, of Temple and Villanova College, and Dr. A. H. Engelbrecht, Austrian UNESCO exchange student, were other members of the high temperature team.

So far the hydrogen-fluorine flame has no industrial use since the combinations of oxygen with aluminum, magnesium and zirconium provide sufficiently high heat for practical purposes.

### *Sulfur in Diet*

► SULFUR in the diet is the key to fast healing of wounds on the battlefield, in accidents or in the operating room. The sulfur is eaten in the form of protein building blocks known chemically as amino acids.

The key role of the sulfur-containing amino acids for wound healing was announced by Drs. Martin B. Williamson and H. J. Fromm of Loyola University School of Medicine in a report to the American Chemical Society.

Not all amino acids contain sulfur. Those that do are found in the proteins of eggs, milk, wheat, corn and some other foods, Dr. Williamson said.

Wounds heal at a much faster rate when the diet is high in protein than when it is low in protein. But when a sulfur-containing amino acid is

### *Key to Healing*

added to the low protein diet, wounds in laboratory animals healed at almost the same rate of speed as those of animals on the high protein diet.

The importance of the sulfur amino acids was also shown by a study of the sulfur balance. During the healing of a wound, this study showed, the sulfur compounds accumulate in the body, whereas proteins in general are lost by excretion faster than they are gained through the diet.

This suggests, Dr. Williamson said, that the tissue proteins are being broken down, but that the sulfur-containing amino acids of protein are being conserved for the healing wound. It appears that during the stress reaction after wounding, tissue protein is being sacrificed to make a greater proportion of sulfur amino acids available for some process connected with healing.

## Butylene Glycol Produced From By-Product in Canada

# Chemical From Sugar Beets

► BY FERMENTATION of sugar beet molasses, scientists at the National Research Council of Canada are now producing a chemical, butylene glycol (2,3-butanediol), on a pilot plant scale. This chemical is promising for use in resins, and as a non-drying and blending agent.

With the yearly increase in Canadian sugar beet production, a more stable demand for the molasses by-product would be created if the new process were adopted by commercial interests.

In the process, molasses, diluted with water and supplemented by the addition of an inorganic phosphate, is fermented by suitable strains of bacteria. Both *Aerobacter aerogenes* and *Pseudomonas hydrophila* give high yields of butylene glycol. Gradual improvements in pilot plant design and operation have resulted in yields of about 175 pounds of butylene glycol and 40 pounds of ethyl alcohol from each 1,000 pounds of molasses. Lesser amounts of other organic compounds are produced but these are not recovered.

In preparing the medium, a continuous method of mashing, sterilizing, and cooling is used. This procedure is more practical for industrial use than batch sterilization and gives satisfactory mashes for fermentation. Following the fermentation, the mash is concentrated by evaporation. Butylene glycol is then separated from the residual solids of the molasses by con-

tinuous steam stripping under pressure and finally removed from the resulting water solution by a series of distillation operations. Ethyl alcohol may be recovered immediately following the fermentation, by the method used in alcohol distilleries.

The initial impulse to the investigation was a war-time demand for butadiene in the synthetic rubber program. Although butadiene can be produced from butylene glycol, other synthetic procedures have proven more practical. Butylene glycol is, however, a highly versatile compound and scientists have investigated other possible uses for the substance.

Although closely related to ethylene glycol, the widely-used antifreeze, the isomer of butylene glycol produced from molasses is not useful for this purpose. Among possible applications for the chemical are the prevention of rapid drying in a variety of materials from tobacco to printers' ink, use as a blending agent for such products as ointments, pastes, dyes, wood stains, etc., as an intermediate in the synthesis of diacetone for flavoring butter or other foods, and as a component of alkyd and polyester resins.

The butylene glycol fermentation is only one of Canada's National Research Council projects involving the use of agricultural and industrial wastes and surpluses. Among the current investigations is research on sulfite waste liquor, a waste product of the pulp and paper industry.

## For the Home Lab

### Acetone

by BURTON L. HAWK

*A is for Acetone—  
An amiable ketone;  
One of the few reagents  
With a pleasing fragrance.*

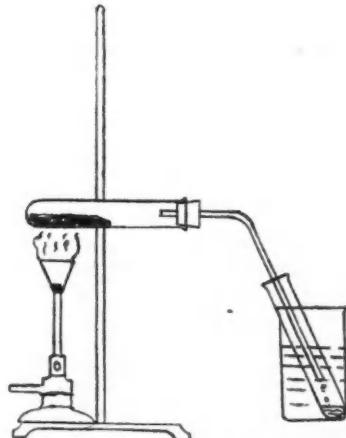
► ACETONE belongs to a class of compounds known as *ketones*. It is a very useful substance, especially as a solvent for oils, waxes, rubber, varnishes, lacquers, resins, pyroxylin, etc. Thus it is an important link in the manufacture of many plastic products, photographic films, artificial leather, paint and varnish removers, rayon, and isoprene. It is also used in the manufacture of the three "forms"—chloroform, iodoform and bromoform.

#### Preparation

Ketones in general are formed by the oxidation of *secondary* alcohols. By oxidation of isopropyl (secondary) alcohol, we obtain *dimethyl ketone*, more commonly known as acetone.

Acetone was first prepared by the distillation of wood, then later by the distillation of acetates and still later by passing acetic acid vapor over heated barium oxide. It is also formed in fermentation reactions.

Of all the above methods of preparation, we believe the distillation of acetates is most convenient for the home lab. Mix together thoroughly by grinding in a mortar 5 grams of calcium acetate and 5 grams of *anhydrous* sodium acetate. Probably the sodium acetate you have will be the crystalline variety. If so, it will be



necessary to drive off the water of crystallization. Simply heat the compound gently in an evaporating dish, stirring constantly. Keep heating through various stages of the liquid state until a dry powder is formed.

Place the mixed acetates in a test tube and clamp it in a horizontal position, as shown in the accompanying diagram. Extend a glass delivery tube from this test tube into another one externally cooled. Spread the powder evenly along the test tube by tapping it gently. Apply heat. If possible, use a Bunsen burner equipped with a wing tip. Continue heating as long as any liquid distils over.

Examine the distillate. You should be able to recognize the pleasant, ethereal odor of acetone. If your

product has a "burnt" odor, redistill carefully.

Pour a small quantity of your acetone in an evaporating dish and ignite. It should burn readily. If it does not, apparently it is diluted with water which, in turn, would indicate that the acetates were not in the anhydrous state.

### Bisulfite Addition Compound

Ketones and aldehydes form a rather unusual solid compound with sodium bisulfite known simply as "bisulfite addition compounds."

To obtain acetone sodium bisulfite, prepare a *saturated* solution of sodium bisulfite. Pour 6 cc. of it in a test tube and immerse the tube in a container of crushed ice and water. Now add 3 cc. of acetone, a few drops at a time, to the cold bisulfite solution. Shake thoroughly after each addition. Finally add 15 cc. of alcohol and shake again. Filter off the precipitate and dry carefully.

To your acetone sodium bisulfite just prepared, add about 5 cc. of 10% sodium carbonate solution and warm gently. Note the odor. Does it resemble acetone? Well, as a matter of fact, it *is* acetone. Actually, this is a method of separating and purifying acetone. If, for example, you have acetone mixed with methyl alcohol (which is often the case when obtained from wood), sodium bisulfite is added, the precipitate separated and distilled with sodium carbonate to obtain the pure acetone.

### Iodoform

Acetone readily forms iodoform and this reaction is often used as a test to determine the presence of acetone. Add 1 cc. of acetone to 10 cc.

of water and make the solution alkaline by adding 1 cc. of 10% sodium hydroxide solution. Now prepare a solution of iodine in potassium iodide (one part iodine, 5 parts potassium iodide and 15 parts water) and add to the acetone solution, drop by drop, until a light yellow color remains after shaking. Let stand and notice the precipitate that forms. This is iodoform. Do you recognize its characteristic "antiseptic" odor?

### Dibenzalacetone

Another reaction of acetone — its conversion to solid dibenzalacetone — is also used as identification. Mix together in a small flask 0.5 cc. of acetone, 2 cc. of water, 2 cc. of benzaldehyde, 2.5 cc. of 10% sodium hydroxide solution and 10 cc. of alcohol and boil gently for about 5 minutes. Cool, shake and filter to obtain the yellow crystals of dibenzalacetone.

\* \* \*

Because of its extreme importance in modern industry, many new methods have been recently devised for preparing acetone. For example, it can be obtained from ordinary alcohol by passing a mixture of the alcohol vapor, steam and air over a catalyst at 400-500 degrees. Or the same method can be used with acetaldehyde instead of alcohol. Acetylene can be converted to acetone in three steps: (1) The acetylene is passed through a mixture of sulfuric acid and mercuric oxide to form acetaldehyde. (2) The acetaldehyde is oxidized to acetic acid by bubbling air through it in the presence of a catalyst. (3) As described above, the acetic acid vapor is passed over a heated catalyst to form acetone. It can also be prepared from propene, obtained from petroleum, by

conversion of the propene into isopropyl alcohol and oxidizing the latter.

We can always be assured that if a product is needed badly, science will find methods of preparing it.

## *Greek Coins Plated With Silver*

► ANCIENT Greek coins that were silver-plated were manufactured by the use of a silver solder placed upon a copper blank, two University of Manchester metallurgists, F. C. Thompson and A. K. Chatterjee, report in a communication to the British journal, *Nature*.

The plated coins were not counterfeit, but officially issued. Previously it was believed that they received their silver coats by a fusion process similar to that used later in the making of Sheffield silver plate in England.

But the Manchester metallurgists have determined that the Greeks in 300 B. C. carried out the plating of coins by making a shallow silver cup to fit the copper core, lining this with a thin sheet of solder consisting of a silver-copper alloy, inserting the copper core and then covering the combination with another inverted cup similarly lined with solder. Reheating fused core and platings together. The plated blank was then struck hot and formed into a coin.

## *Society's Structure Is "Atomic"*

► IT IS an atomic world, even in human relations and the structure of society.

Prof. George P. Murdock, Yale anthropologist, in a paper before the National Academy of Sciences recently, likened man and woman to two basic types of human atoms, each with several phases, which are infancy, childhood, maturity and senescence.

In maturity, these two kinds of human atoms, Dr. Murdock said, "have a special affinity for each other, producing marriage and a localized family organization in every known society."

Male and female can unite in only three combinations, he explained. There is monogamy. There is polygamy, which is plurality of wives,

and also polyandry, in which the woman has more than one husband at the same time.

There are four modes of residence and three rules of descent classified by anthropologists. The local group may be migratory or sedentary. They may or may not be linked to others by political bonds.

All the factors may be taken mathematically in permutations and combinations to define the limited number of fundamental structural or molecular systems of human society, Dr. Murdock has found.

He finds that all the 3,000 to 4,000 known human societies can be fitted into this scheme, much as the chemist can write a formula for each of the compounds that he analyzes.

**Scientists Seek Profitable New Outlets  
For a Plentiful Component of Wood**

## Lignin

by G. HARVEY BENHAM

*Supervisor of Biochemistry, Armour Research Foundation of Illinois Institute of Technology*

► LIGNIN, the non-cellulosic component of wood, comprises up to 40 per cent of whole wood on a dry basis. Consequently, it constitutes one of the largest raw material sources. Only lately have its potentialities been investigated. The various pulping processes for the production of paper produce enormous quantities of lignin in the waste liquors, and it is estimated 10 million tons of lignin were available in the United States in 1949. About half of it was utilized for fuel, as its high carbon content (65 per cent) gives it a fuel value of 10,500 BTU/lb. However, most of the remainder was discarded and threatens to become a water-pollution problem. Only 3 per cent of the lignin from the sulfite paper processes finds a commercial outlet.

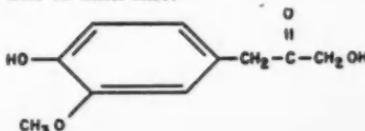
Lignin is also produced in the saccharification processes of wood chips, sawdust, and waste that is not available for paper production. This process, perfected largely in Germany, might become commercially feasible if the lignin credit were 1.5 cents per pound, but various commercial lignin sources specify at least 20 cents per pound. With such large amounts of inexpensive raw materials available, it is interesting to study the chemistry of lignin in order to get a clearer understanding of this unique material.

The chemistry of lignin goes back

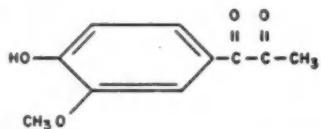
to 1870 when Klason first obtained vanillin in low yields. But the analytical chemist has been left with a negative approach to lignin, which has been designated as that material of vegetable origin not solubilized by 72 per cent sulfuric acid under prescribed conditions. Early workers in Germany, Fleschig<sup>5</sup> Willstatter<sup>13</sup>, and Wohl and Krull<sup>14</sup> studied its properties. But the fundamental work of Freudenberg<sup>6</sup> in Heidelberg and Hibbert<sup>8,9</sup> in Montreal, laid the basis for modern lignin chemistry.

The first important finding was that not only is lignin altered by most procedures which are able to dissolve it from wood, but also that all acid treatment produces modifications. This meant that the material under study varied from laboratory to laboratory. Furthermore, lignins from different sources, when subjected to the same treatment, showed a wide variation in properties.

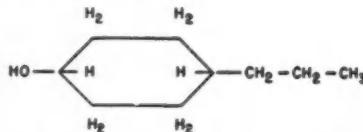
Painstaking work using milder treatments have now shown that lignins prepared in various ways may all be regarded as products resulting from the etherification and condensation of units like:



The evidence for such propyl benzene derivatives is overwhelming; not only does mild oxidation with alkaline nitrobenzene, alkaline silver oxide, or cupric oxide yield vanillin up to 25 per cent, but the whole unit is obtained intact by ethanolysis and mild oxidation, in which a whole series of oxygenated compounds is formed, such as:



Pressure hydrogenation yields important cyclo-hexyl propane derivatives, for example:

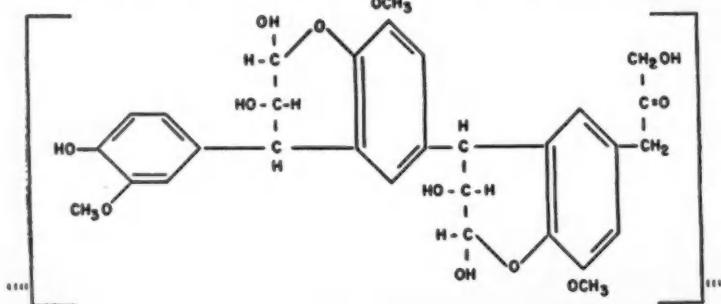


How are such units condensed together in the actual raw or native substance? By careful extraction with butanol or ethanol, small amounts of polymers of molecular weight of 945, measured cryoscopically, have been obtained by Buchanan, Brauns and

others<sup>2,3</sup>. Such a molecule has 14.8 per cent methoxyl and up to six free hydroxyl groups of which only one is phenolic. In addition, spectroscopic evidence suggests one or more pyran rings. A tentative formulation for such a molecule is shown below, in which the basic unit is thought to occur five or six times.

However, larger polymers are obtained by more rigorous treatments. This is because inter-etherification of similar building stones proceeds rapidly. In order to obviate this and perhaps obtain a low molecular weight unaltered polymer, Lieser and Schack<sup>11</sup> have recently reported that they use low temperature nitration for blocking free hydroxyl groups and are currently studying the nitro-lignins obtained. Substitutions both in sidechain and rings will probably yield many new and interesting derivatives which might find a variety of uses.

Large numbers of such uses have already been found, especially for the sulfonated derivatives. But the very reactivity of this molecule should produce substances of a unique nature. For such a study, sources differences and extraction procedures must be thoroughly understood. This phase of



lignin chemistry is just beginning. Bailey in Washington<sup>1</sup> has just reported chromatographic work on lignins from six different sources and found heterogeneous systems in each case. Mixed chromatograms of similar bands from different sources, however, show less heterogeneity than that from any one source. It is possible that there are, coexistent in a given source, lignins of different degrees of polymerization. Different parts of the wood have been shown to vary in lignin composition. All these ramifications suggest that lignin is a generic term like peat, coal, or oil, and that a nomenclature for individual components is needed. Differences in methoxyl content have already been reported, as well as data on molecular weight and solubilities. However, it is doubtful whether yet true native lignin has been thoroughly described. It is not difficult to see that much work needs to be done before a real understanding of the enormous field is gained.

Nevertheless, many outstanding properties are known. Lignin is prepared as a finely divided near-white powder of amorphous nature, with limited swelling capacity, and not subject to the uptake of much water. Lignin has low tensile strength, and its mechanical properties are equal in all directions. This latter concept is supported by the fact that the thickness of a layer of the azobenzene sulfonic acid salt of lignin gives values of 20A°, indicating a three-dimensional picture. This property, among others, has enabled lignin to find a place in polymer chemistry.

Uses and applications in this field are already the basis of quite an im-

pressive list of patents in the fields of adhesives, plastics, resins, and rubber. Its surface active properties have been used in the fields of flotation, emulsification and adsorption.

Nevertheless, it is important to realize that lignin has not been found to have a wide and profitable outlet which it alone can fill. This is surprising because by all chemical criteria, lignin with its aromatic nuclei is unique among naturally occurring products. It is, moreover, at once a reactive and a stable material. Its reactivity is shown by considering the units in its formula and its stability is shown from the standpoint of resistance to enzyme action. It has a digestibility of nil even in herbivorous animals. The lignin-carbohydrate ration increases during the "life" of peat, indicating the great stability of lignin to attack by microorganisms. Olsen, Peterson, and Sherard<sup>12</sup> specify that lignin-destroying organisms do exist, but only recently has there been significant work on this subject. Heuser et al<sup>8</sup> in Appleton have tried to obtain specific lignin-destroying organisms which do not attack cellulose, and Gottlieb<sup>7</sup> has screened thirty-five wood rotting fungi for lignin decomposers. Such fungi had to be adapted to use lignin by gradually decreasing glucose in the medium to zero until lignin was the limiting carbon source. Two of these cultures, *Polyporus abietinus* and *Poria subacida*, did this successfully. The decomposition products of such fungal action are currently being studied, and this should provide new approaches to the lignin molecule.

Another approach which merits investigation is to study the biogenetic origin of lignins. Even though Nord

suggests the possibility that it is produced by micro-organisms, the pathways whereby lignin is produced from the primary products of photosynthesis have been under theoretical discussion for some time. There is a need for practical work along the lines recently reported by Fernandez and Garito<sup>4</sup>. These workers claim that a primary lignin exists and that it contains no methoxyl. They also claim to have obtained such lignins from dried grape epicarp, amounting to 50 per cent on a dry weight basis. Whole grape seed powder, however, yielded a 4 per cent methoxyl lignin. The products were similar except for methoxyl content, and the fact that the first product was in a lower state of polymerization than the second. Studies such as these may eventually produce findings to point out how lignin arises, so that the natural developmental chemistry of this important group of substances may be understood and put to practical use.

This inexpensive and plentiful source of material exists, but we need to develop the chemistry of lignin to the point where cheap processes can be applied to the production of useful materials. Only then will another step have been taken toward the better conservation of the earth's natural resources.

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## Cheap Products Save Waste Materials

► Low cost manufactured gas is produced by a new process from powdered fuel and air, a French chemist told the World Chemical Congress in New York recently.

Peat, lignite, brown coals, soft coal or atomized fuel oil are mixed with steam and either air or oxygen. Chemical action occurs, and the process is continuous, Dr. Kurt Baum of the Pan-European Industrial Plants Co., Paris, explained.

Many thousands of tons of wood waste that would otherwise be lost

can be made into strong hard wallboard by a process described by Dr. Louis G. Ricciardi of the Polytechnic Institute of Brooklyn. Instead of using expensive resins small amounts of simple inexpensive chemicals are used to unite chemically with the lignin in the wood to cause it to become an effective binder.

In addition to sawdust, chips, shavings, slabs and edgings of wood, the process can use straw, sugarcane, bagasse, sisal fiber, coconut fiber, and waste from other vegetation.

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## Fluoridation for Prevention, Antibiotics for Cure

# Teeth Saved by Chemical Treatments

► MANY a person's two front teeth have been saved by aureomycin and penicillin, Dr. Edward L. Sleeper of Tufts College Dental School, Boston, reported to the American Dental Association meeting.

The mold drugs are used to clear up infection in cases of abscessed teeth. Practically all such teeth can be saved, no matter how severe the infection.

Many front teeth, in younger individuals especially, have been so loose when acutely involved that they could have been extracted with one's fingers, Dr. Sleeper said.

Yet, when the infection was under control and the tooth root canal filled and treated, the patient had a functional tooth of his own.

"Pyorrhea" no longer means the patient is doomed shortly to lose all his teeth, as it did 25 years ago, Dr. Harry B. McCarthy of Baltimore reported.

The term then was used for most ailments of mouth tissues and gums and it was widely believed that there was no cure for it.

Dentists now know more about ailments of these tissues, called periodontal tissues, and are equipped to treat them. The attitude of defeatism dentists once had for such ailments is fast passing out of the picture, Dr. McCarthy said.

We can safely tell our patients, except those with very advanced perio-

dental involvement, that we can, with adequate treatment on our part and the proper home care on their part, retain their teeth and supporting tissues in a healthy condition for many years.

### Fight Against Tooth Decay

► ONLY ABOUT three-quarters of one percent of America's public water supplies are now adding the tiny amount of fluorine that promises to make the coming generation's teeth more nearly free from decay.

But the dentists, water works engineers and public health experts who are urging fluoridation of water we drink are not discouraged by this fact that only 120 out of the more than 15,000 public water supplies of the nation are fluoridated.

The one big hope of preventing dental caries—decayed teeth in simple words—is treating growing teeth with amounts of fluorine so small that they produce no other effect on human health. This is the biggest dental discovery in recent years, in the opinion of many experts. It produces about a two-thirds reduction in the dental decay rate of children. Too much fluorine occurring naturally in drinking water causes unsightly mottled enamel of teeth. Surprisingly, mottled teeth were more free from decay than prettier teeth. It was found that adding the chemical to teeth, in drinking water or by swabbing it on in the dentist's office, protected teeth from decay in later years.

The U. S. Public Health Service and several other investigators developed the methods. Guinea pig cities, one with fluorine added to its water matched with another left alone, proved that children's teeth could be protected. The rush began to add fluorine to water so children could drink away future toothaches.

Wisconsin is the most fluoridated state. Sixty out of the 120 treated water supplies are in that state.

But the fluorine rush for better teeth is on. Almost every state's health department is helping communities prepare for fluoridating their water, much as a number of years ago chlorination was introduced to clean up polluted water supplies that were spreading water-borne diseases.

Civic clubs, women's organizations and newspapers in various localities, as well as dental and health associations, are campaigning for fluoridation of water supplies.

Some difficulties arise in the program:

As often happens with new methods, some misinformed individuals are contending that addition of the minute amounts of fluorine to water is dangerous. There is no good evidence to support such ideas.

State and local health departments, and water works, are limited by facilities and personnel in the speed with which the fluoridation program can be put into operation. One typical state can extend the method to only one city each month. There is also a limit to the amount of the necessary chemicals that can be produced industrially in the forthcoming months.

Money is also necessary to operate the program and install the method, although this amounts to only a few cents each year for each person benefited. Federal funds to aid states have been limited severely by Congress.

Not all the population can be reached with the fluorine chemicals in public water supplies. The millions in very small towns and in rural areas, who drink spring and well water, will need to have their children go to dentists to have the chemicals swabbed on their teeth by a process called topical fluoride applications.

There are a few favored areas where there is enough fluorine naturally in the water to protect future teeth, but there are less than 1,500 of these cities with natural fluoridation. Some areas of excess fluorine content in their water may actually have to remove some of it to prevent mottled enamel.

### **Cost of Fluoridation**

► FOR A MERE two dollars a baby today can have lifetime protection of his teeth against decay. In round numbers, that is what it costs per person if the community fluoridates its water supply. More specific figures are given by Dr. Herman E. Hilleboe, Commissioner of Health for New York State, as follows:

Cost of fluoridation per person is five to 15 cents annually, depending on the amount of natural fluorine in the community water supply. Fluoridation, trials in some communities over the past several years show, will reduce the amount of tooth decay expected by about two-thirds. If a person lives to be 70 years old, which is about what children born this year can expect, he will receive for the total

cost of \$2.10 an expected reduction of 67 per cent in tooth decay.

Fluoridated water is water to which a small amount of a fluorine salt is added. There is no danger to health from this water if treatment is properly done. Children drinking this water from birth get enough of the fluorine to protect their teeth from decay to a large extent. Even older children get some benefit from such water. More and more communities are fluoridating their water supply.

If this trend should continue, Dr. Hilleboe predicted, we may reach a point where with the present complement of practicing dentists we may be able to treat such caries as may occur and reduce tooth mortality and untreated caries to a negligible level.

### **Scientists OK Fluoridation**

► ONE OF the top scientific organizations of the country, the National Research Council, has joined forces with dental and health authorities in favoring fluoridation of public water supplies to reduce tooth decay.

Properly controlled, the addition of fluorides to drinking water which lacks these chemicals appears to be both safe and effective, states a report from the NRC.

Hailed by some as reducing dental decay by two-thirds, and opposed by others as of questionable value and possibly dangerous, fluoridation has been the subject of controversies in many cities throughout the country. Last spring the NRC appointed a committee to study the evidence on both sides and give an impartial answer.

While endorsing fluoridation, the

committee cautions that its safety depends on proper controls and its effectiveness on proper selection of water supplies for treatment. Among the points emphasized are these:

Fluoridation should be considered by any community which includes a child population of sufficient size, and which obtains its water supply from sources which are free from or extremely low in fluorides.

The actual reduction in dental caries will vary according to local conditions. The widely quoted figure of 65 per cent is a prediction applying only to communities whose water contains no natural fluorides at all. Benefits in many cases would be much less.

Protection is gained chiefly by drinking fluoride-containing water while the permanent teeth are being formed, or up to about 12 years of age. However, this protection lasts to some extent into adult life.

There is no evidence that fluorides are harmful in the very small amounts (about one part in a million) needed to reduce caries. Probably 5,000,000 Americans drink water with this much or more every day. However, it should be undertaken only under expert dental and engineering supervision by the state board of health, with constant chemical control. Less fluoride should be added in warm climates where more water is consumed.

Fluoridation is only a partial caries control procedure and does not eliminate the need for other dental health measures.

About one-half of the population of this country is rural and does not use public water supplies. Other provisions for preventing dental caries in

this fraction of the population should be continued and developed.

Chairman of the committee is Dr. Kenneth F. Maxcy, The Johns Hopkins University School of Hygiene and Public Health, Baltimore, Md. The membership includes Dr. J. L. T. Appleton, School of Dentistry, University of Pennsylvania, Philadelphia; Dr. Basil G. Bibby, director, Eastman Dental Dispensary, Rochester, N. Y.; Dr. H. Trendley Dean, director, National Institute of Dental Research, U. S. Public Health Service, Bethesda,

Md.; Dr. A. McGehee Harvey, The Johns Hopkins University; Dr. Francis F. Heyroth, Kettering Laboratory, University of Cincinnati College of Medicine, Ohio; Dr. A. LeRoy Johnson, Great Barrington, Mass.; former head of the Harvard School of Dental Medicine, and dental consultant, National Research Council; Prof. Harold A. Whittaker, University of Minnesota School of Public Health, Minneapolis; and Dr. Abel Wolman, The Johns Hopkins University.

## *Fluorocarbon Spray Aids Transformers*

► THE RELATIVELY new chemicals known as fluorocarbons, when used as a cooling spray, greatly increase the efficiency of electrical transformers, Westinghouse scientists find.

These chemicals permit the delivery of 3.5 times as much power as is produced by conventional oil-cooled transformers. This comes from the ability of the fluorocarbons to dissipate by vaporization 10 times as much of the heat created in the transformer.

Transformers are the familiar black metal boxes on electrical distribution systems that cut the voltage of the current from feeder lines to safe limits to use in a building. This new cooling system will probably find its first applications in the giant transformers which reduce the extremely high voltage used in cross-country power lines to lower voltages for local distribution.

Fluorocarbons are similar to the hydrocarbons of petroleum but differ in that all the hydrogen is replaced by fluorine. They are synthetic com-

pounds, made by a new electro-chemical process, which entails no use of the dangerous free fluorine. There is no natural source of fluorocarbons corresponding to petroleum and coal for hydrocarbons.

The development of fluorocarbon cooling sprays for transformers is the result of work by scientists of Westinghouse Electric Corporation at Sharon, Pa. As explained by Dr. Paul Narbut, Westinghouse engineer, instead of filling the transformer tank with oil, a small quantity of liquid fluorocarbon is stored at the bottom of the tank.

This liquid is pumped to a nozzle that sprays it directly on the hot transformer core and coils. The heat evaporates some of the liquid. The vapors formed then circulate toward the cooling surfaces of the transformer tank where they condense and release the heat taken from the coils. The condensed liquid flows back to the bottom of the tank for reuse.

Chemicals From Blood.  
Dextran Saves Plasma

## Blood Research Makes Discoveries

► A BLOOD chemical that may turn out to be a heart stimulant has been discovered more or less accidentally by Dr. K. Laki, visiting scientist at the U. S. National Institute of Arthritis and Metabolic Diseases in Washington.

The accidental part of the discovery is that it was made in researches on the clotting mechanism of the blood. Previous research had suggested that when thrombin in the blood acts on another blood chemical, fibrinogen, to make it clot, the thrombin action may split a chemical bond in the fibrinogen molecule and free a small chemical molecule from the fibrinogen. This would leave a slightly altered fibrinogen molecule, presumably the one that becomes a gel and makes the blood clot when shed.

Proof of such a mechanism would rest on finding the smaller molecule split from the fibrinogen. By a method reported in the journal, *Science*, Dr. Laki has obtained this small molecule. Tests with it showed it could stimulate a frog's heart.

Further studies to determine its chemical nature and to learn whether this blood chemical is a heart stimulant that could be used medically are now in progress.

### Serotonin Synthesized

► A BLOOD chemical twice as powerful as adrenalin for fighting shock has now been made synthetically in the laboratory.

The chemical is called serotonin. Successful synthesis of it has been announced by Drs. Merrill E. Speeter, Richard V. Heinzelmann and David L. Weisblat of the Upjohn Company in the *Journal of the American Chemical Society*.

Crystals of serotonin were isolated from blood platelets in 1948 by Dr. Maurice M. Rapport, now with Sloan Kettering Institute, New York. At that time scientists hoped to get enough of the crystals to test the chemical as a remedy for shock and for patients with some kinds of heart disease. But in 1948 Dr. Rapport and associates got only a pinch of the crystals from a very large quantity of blood.

The chemical acts to constrict small blood vessels and therefore is believed to have a blood-pressure-raising effect.

Now that it can be made synthetically, scientists are finding new possibilities for it. Blood loss from wounds in experimental animals, such as laboratory rats, is markedly reduced when the animals are given serotonin. This is true even when wounded animals have been given heparin, the anti-blood clotting agent which usually causes small wounds to bleed profusely.

It may be useful as a nasal decongestant, as a counter measure for overdoses of anticoagulants such as heparin and dicumarol, in treatment of the bleeding disease, hemophilia,

and in some kinds of surgery such as brain operations where it is essential to keep a dry field free from the bleeding from many tiny blood vessels. All these possibilities will be investigated by the Upjohn scientists.

Chemically, serotonin is 5-hydroxytryptamine.

#### "Volemic" New Name

► A NEW NAME for blood plasma substitutes such as gelatin, dextran and periston or PVP has been coined by Dr. Jesse L. Bollman of the Mayo Clinic, Rochester, Minn.

"Volemic substances" is Dr. Bollman's new word for these chemicals. They are also sometimes called blood or plasma volume expanders because their effect is to expand the volume of fluid in the blood circulation.

#### Dextran Rated Best

► DEXTRAN, a sugar chemical substitute for blood plasma in cases of shock, is rated first among four blood plasma substitutes in experiments at the Mayo Clinic and Foundation, Drs. Robert C. Knutson, Jesse L. Bollman, and John S. Lundy reported to the recent meeting of the American College of Surgeons at San Francisco. The experiments were designed to test ability of these chemicals to restore blood volume after a measured, acute hemorrhage.

The other three chemicals, in descending order of effectiveness in these experiments, were: gelatin, acacia and periston, or polyvinylpyrrolidone, also known as PVP for short.

Dextran's effectiveness in fighting shock in 20 patients who had been wounded or were suffering from intestinal strangulation was also re-

ported by Drs. B. W. Haynes, Jr., and Michael E. De Bakey of Baylor University College of Medicine, Houston, Tex.

The chemical, they found, was effective for early resuscitation of patients with wound shock. Depending on the kind of wound, the surgery needed to repair it and the amount of blood lost, dextran may give enough support to the circulation to enable the surgeon to repair the wound without giving whole blood. Or it may reduce to a minimum the amount of whole blood needed to carry the patient through the operation.

Anemia may result from use of dextran for patients with wound shock. But a distinct advantage achieved by the use of dextran is that whole blood transfusion does not have to be given immediately in an emergency but can be given later.

Patients with extensive injuries and severe blood loss cannot be resuscitated with dextran alone, the Houston surgeons emphasized. Whole blood will be needed in such cases.

#### Red Cell Transfusions

► Blood in blood banks all over the country can be used more economically if the fluid part, or plasma, and the red cells are used separately according to the patient's need, Drs. Donald W. Smith and John Elliott of Miami, Fla., declare in the *Journal of the American Medical Association*.

Of the 28,000 transfusions prepared each year at the Dade County, Fla., blood bank, about 15 per cent are given as suspensions of red blood cell's. Another 15 per cent are given as plasma. This means that 15 per cent of the blood collected does double duty.

The chief conditions in which red blood cells instead of whole blood will be good medicine for the patient are listed by the Florida scientists as follows: 1. uncomplicated anemia of the iron deficiency type; 2. anemia in heart disease, high blood pressure or kidney disease where an increase in blood volume is not desirable; 3. anemia in cases in which it is necessary to get a quick, effective increase in the oxygen-carrying capacity of the

blood; 4. preparation of anemic patients for surgery when their blood volume is normal.

Details of how to calculate the dose of red cells needed by a patient and of how to prepare the red cell suspension are given with a plea not to waste plasma by giving whole blood when only red cells are needed. This economy, the doctors state, permits stockpiling of more plasma for emergency or wartime needs.

## *Selenium in New Dandruff Treatment*

► Greasy, yellowish scales on the scalp and common dandruff can be checked in most cases by an electric eye chemical, selenium, plus sulfur, longtime standby for treatment of scalp and skin disorders.

Selenium sulfide's ability to control dandruff and the scaly itching scalp condition, medically termed seborrheic dermatitis, was discovered some 25 years ago. In the interval the chemical has been given many tests and trials and now Abbott Laboratories announce a selenium sulfide product for medical use called Selsun.

Because selenium is poisonous when swallowed, the scalp remedy will be sold only on a physician's prescription. Tests have shown that it is not harmful when used on the scalp according to the doctor's directions.

The original discovery of the chemical's anti-dandruff power was suggested by Dr. Birger W. Nordlander, research chemist at General Electric

Co., who fused selenium with sulfur to get a chemical that would detect mercury vapor in the air. Because this product was a very active form of sulfur and because sulfur has long been used for treating skin diseases, Dr. Nordlander suggested its medical use to Drs. B. L. Vosburgh and Glenn Smith of General Electric's medical department.

While it proved successful, General Electric did not want to continue producing it for medical use. A research and testing program was carried out under the auspices of the Battelle Memorial Institute at Columbus, Ohio. Abbott Laboratories at North Chicago assumed the final development, research and production problems.

Their product is reported to control 92% to 95% of cases of mild or common dandruff, and 81% to 87% of seborrheic dermatitis. The chemical, however, is not a cure. When its use is stopped, dandruff will eventually come back.

Because of a growing shortage of bronze, steel coated with a bronze or brass lacquer is being used as a substitute.

## New Metal Combinations, Other Improved Materials

# Technical Processes in Recent Patents

*Patents may be ordered by number from the Commissioner of Patents, Washington 25, D. C., at twenty-five cents per copy. Send remittance in coin, money order or U. S. Patent Office coupons, but not stamps.*

### Aluminum on Iron

► MOLTEN aluminum applied by the hot-dip process to objects of iron will form a coating highly resistant to flaking or peeling by a discovery that brought Daniel O. Gittings, Pittsburgh, Pa., patent 2,565,768. Rights are assigned to the United States Steel Company.

His discovery is that a high-quality aluminum coating will result if a very small amount of beryllium is added to the aluminum coating bath. The amount of beryllium may vary from less than one-tenth of one percent up to two percent. In the finished article there is a thin, relatively soft beryllium-containing iron-aluminum alloy layer between the iron object and the outer aluminum coat that prevents the coating from cracking even under severe bending tests.

### Improved Casein Fibers

► TEXTILE fiber of casein from milk will be more durable and have improved chemical and physical properties, it is claimed, by a process utilizing titanium, zirconium or tin salts as a hardening agent.

The inventors claim they have found that they obtain an improved casein fiber by treating the artificial

material after coagulation, but before drying, in a water solution of a salt of a metal selected from the group consisting of titanium, zirconium or tin. In addition to improved chemical and physical properties the resulting fiber is curly and has acquired wool-like properties.

Inventors of the process are John F. Corwin, Unadilla, John R. Calhoun, Bainbridge, and Thomas M. Buzzo, Unadilla, N.Y. Rights are assigned to the Borden Company of New York City. The patent number is 2,567,184.

### Mercury-Coated Nickel

► THE VERY long time required in the past to coat nickel with mercury, important in the electrical industry, is cut to a very short time with a method which brought Theodore M. Burkholder, Newton, Mass., patent 2,567,762 with rights assigned to Raytheon Manufacturing Company of the same city.

In the process, the nickel to be coated is immersed first in a solution of one part water and seven parts nitric acid for one to two minutes. After washing, it is then immersed in concentrated hydrochloric acid up to 30 seconds. It is then stuck into a bath of mercury which has dilute hydrochloric acid floating on top. It is agitated in the acid for about ten seconds, then dipped into the mercury for another period of the same length. It then has acquired a coating of mercury.

### Harmless Fungicide

► PLASTIC shower curtains, seat covers and other equipment in the home are safe from damage by fungi or bacteria if made of an especially treated polyvinyl chloride composition which contains certain chemicals destructive to organisms. It is claimed that the treatment does not injure the ordinary properties of the plastic as sometimes happens in other processes.

Inventor is Walter E. Field, St. Louis, Mo. Patent 2,567,905 was awarded to him. Rights have been assigned to Monsanto Chemical Company, also of St. Louis.

In the treatment a copper quinolinolate, well-known fungicide and bactericide, is used. The use of this copper chemical alone has been previously tried but it caused deterioration. In this process another chemical offsets the deterioration. It is one of the benzenesulfonamides or toluenesulfonamides.

### Aluminum Coated Steel

► THE DIFFICULT job of coating steel or iron with aluminum commercially is claimed to be solved with a process which brought patent 2,569,097 to Howard L. Grange, Darlington, Wis., and Dean K. Hanink, Birmingham, Mich. General Motors Corporation of Detroit has acquired the patent rights.

Steel or ferrous metal of any shape can be coated with pure aluminum or aluminum base alloys by this method, it is claimed. The process may be a continuous one if desired, particularly when the metal being coated is sheet, wire or rod stock.

In the process the article to be coated is immersed in a molten salt floating on top of molten aluminum.

The molten salt is about 80% a mixture of potassium chloride and sodium chloride, the rest being cryolite and aluminum fluoride. The salt bath has a melting point of about 1180 degrees Fahrenheit. After the steel or other ferrous metal has been heated in the bath to or above the melting point of aluminum, it is immersed in the molten aluminum where it becomes coated with the light protective metal.

### Silicon Rectifiers

► A SEMICONDUCTIVE metal, usable in rectifiers to convert alternating electric current to direct current, is largely silicon, with very small amounts of other metals added to give the effect and particular characteristics desired. These additives are boron or aluminum for one purpose and phosphorus, arsenic or antimony for another.

Patent 2,567,970 was issued to Jack H. Scaff, Summit, N.J., and Henry C. Theuerer, New York. Patent rights are assigned to Bell Telephone Laboratories, Inc., New York.

### Lightweight Concrete

► A LIGHTWEIGHT aggregate to replace the usual heavy gravel used in making concrete is made by treating certain by-products of the phosphate mining industry but can use similar material from other sources. The material is a phosphatic volcanic ash. This by-product of the pebble phosphate deposits of Florida bloats or expands with the production of many small cells or pockets when heated to temperatures of 1600 to 2100 degrees Fahrenheit.

A process of making a lightweight aggregate for concrete from this phosphatic volcanic ash brought patent 2,569,323 to Poole Maynard of At-

lanta, Ga. In his method the ash after drying is made into pellets which are fired in a rotary kiln for about ten minutes at a temperature above 1600 degrees Fahrenheit. The bloated pellets are then crushed. The resulting product has a weight around 25 to 30 pounds per cubic foot, as compared with the usual gravel which weighs about 125 to 150 pounds per cubic foot.

#### **Farmer's Flame Thrower**

► AN IMPROVED flame thrower for killing weeds and grass growing among stemmed crops, such as corn and cotton, brought patent 2,569,194 to Stuart D. Pool and Bernise J. Shager, both of Moline, Ill. Rights are assigned to International Harvester Company. The device provides a coreless flame and a burner which directs a broad flat flame upon the ground in such a way that the flame clings to the surface and flows across the plant row.

#### **Strong Magnesium Alloy**

► MANY NEW applications for the metal magnesium are promised with a new alloy which unlike some others has tensile strength at elevated temperatures. The metals used with the magnesium are little known to most people, being what chemists call rare earth metals.

In the alloy, 90% or over is magnesium. The other metals are cerium, neodymium and praseodymium. The

latter two are supplied by using didymium, a mixture once supposed to be an element. The amount of the cerium used is from 25% to 75% of the rare earth metal content. Other rare earth metals that may be present as impurities in didymium or cerium are not harmful.

Inventor of this alloy is Thomas E. Leontis, Midland, Mich. He received patent 2,569,477. Rights are assigned to Dow Chemical Company, also of Midland.

#### **Liquids to Fight Fire**

► BURNING gasoline, as well as fire in practically all combustible materials, is rapidly extinguished in early stages with the use of fire extinguishing liquids which brought patent 2,569,979 to Charles G. Durfee, Teaneck, N.J., and George E. Ferguson, Spring Valley, N.Y. Pyrene Manufacturing Company, Newark, N.J., has acquired patent rights.

The liquids used are mixtures of methylene bromide and another brominated hydrocarbon. The preferred mixture is from 85% to 95% methylene bromide and the rest bromoform. Both of these materials are fire extinguishers and can be used alone. But the mixture is more effective than either. It is more effective than the long-used methyl bromide and chlorobromomethane and has an added advantage in not being injurious to a person's skin or clothing.

The rise in the use of synthetic rubbers, especially "cold-rubber," has increased greatly the demand for the type of carbon black known as high abrasion furnace black.

Scientists predict that some 200,000 tons of American corncobs and oat hulls will be used each year in making furfural, an intermediate in manufacturing nylon.

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Notable Advances in England  
Mark Past Hundred Years

## A Century of British Chemistry

Reprinted from *Endeavour*

THE PERIOD between the Great Exhibition of 1851 and the Festival of Britain in 1951 includes many notable achievements of British scientists in all departments of chemistry. It comprises, for example, the first recognition of valency — by Edward Frankland in 1852. During the earlier part of the period, this idea was for the most part applied in organic chemistry, but it served, too, as a unifying principle in the study of elements other than carbon. It gradually became clear, however, that the simpler views of valency which rendered such valuable service in organic chemistry were insufficient in the remaining field, and here the theory of co-ordination compounds, proposed by Alfred Werner of Zürich in 1893, acted as a guide. Significant contributions to the study of such compounds were made in the 1920's by Sir Gilbert Morgan, and an explanation of their structure in terms of the electronic theory was given by N. V. Sidgwick, who employed with much success the conception of a co-ordinate link as a special case of an ordinary valency bond. Cognate with theories of valency is the classification of the elements, and we may recall the tentative gropings towards the periodic system made by W. Odling and J. A. R. Newlands.

One of the most successful British workers in the realm of inorganic chemistry was Sir Henry Roscoe,

whose researches on vanadium are models of chemical investigation. Sir William Crookes made an intensive study of the rare earths, and in 1861 discovered thallium. Later in the period came the romantic story of the discovery in the atmosphere of a whole family of new elements — the inert gases — as a result of the brilliant work of the third Lord Rayleigh, Sir William Ramsay, M. W. Travers, and others.

From the time of Davy and Faraday, physical chemistry has always had a strong attraction for British chemists. Chemical kinetics has been a favourite subject with them and is therefore selected for special mention here. In 1866, a year before the satisfactory enunciation of the law of mass action by the Norwegians C. M. Guldberg and P. Waage, the underlying idea had been used in a particularly noteworthy study by A. G. V. Harcourt and W. Esson at Oxford; their work may be said to have formed the basis, both in theory and in experiment, of the modern science of chemical kinetics. On the experimental side, useful contributions were made by J. H. Gladstone and the Irish scientist J. H. Jellett, while in the difficult region of gas reactions the work of H. B. Dixon, begun in 1884, was of fundamental importance. Incidentally, it may be remarked that Dixon's discovery of the curious influence of water on many chemical

reactions, a discovery ably pursued by his pupil H. B. Baker, had considerable effect on theoretical views on catalysis. The study of gaseous explosions by Dixon was continued by W. A. Bone and R. V. Wheeler and is still engaging the attention of other British chemists. Our knowledge of chemical kinetics in general has in more recent years been advanced by such workers as Sir Cyril Hinshelwood and E. A. Moelwyn-Hughes, who have not only greatly added to the experimental data but have suggested theories commanding wide support.

Roscoe did not confine his interest to inorganic chemistry alone; he conducted much research on physicochemical problems. His experiments on liquid solutions were of great accuracy, but it is perhaps his study of the action of light on chemical changes which is best known in this field. Early work on the action of light on the combination of hydrogen and chlorine was done by Dalton and by J. W. Draper (an Englishman who emigrated to America), but the work of R. W. Bunsen and Roscoe, begun in 1855, was in effect the foundation-stone of modern photochemistry. Photochemical work has been actively continued in Britain ever since.

The wide domain of colloid chemistry, opened by the pioneer researches of Thomas Graham, has been cultivated with success by many later British chemists. Of outstanding workers on the subject, mention may be made of S. E. Linder and H. W. Picton, Sir William Hardy, and Sir Eric Rideal. Rideal, J. W. McBain, and N. K. Adam have also made notable contributions to the study of adsorption.

Limitations of space preclude a description of the part played by British workers in development of other branches of physical chemistry, such as electrochemistry, thermochemistry and thermodynamics, and the phase rule, but it is not too much to say that it has won equal success.

A century ago, the development of organic chemistry had reached a particularly interesting stage. The fundamental problem of organic molecular constitution was approaching a solution. Liebig's earlier view of organic chemistry as the chemistry of compound radicals led up through many stages to the idea of mixed types, based by A. W. Williamson on work on ethers (1850-2). Frankland's theory of valency, already mentioned, was soon followed by A. Kekulé's recognition, in 1858, of the quadrivalence of carbon and the linking of carbon atoms. These ideas, and the related theory of organic molecular structure, were entertained simultaneously by the neglected Scottish chemist A. S. Couper. Both Kekulé and Couper put forward representations of organic molecules which bear a close resemblance to modern structural formulae. Crum Brown introduced graphic formulae in 1865, showing each individual valency bond. These structural representations of organic molecules, arising partly from the work and ideas of British chemists, have been mainly responsible for the amazing developments of pure and applied organic chemistry in the succeeding period.

In 1856, W. H. Perkin senior (later Sir William) obtained mauveine when trying to prepare quinine artificially. He later built the first dyestuffs fac-

tory, and the latent possibilities of coal tar as a source of unending synthetic dyes, perfumes, and fine chemicals of many kinds soon became apparent. The consequent flood of successful research was guided by the theory of organic molecular structure that had synchronized so closely with Perkin's original discovery.

In Britain, the development of organic chemistry owed much at this time to chemists who had been trained, between 1846 and 1864, at the Royal College of Chemistry, London, under the direction of A. W. Hofmann. Hofmann pictured England as becoming 'the greatest colour-producing country in the world,' but the temporary support of chemistry died down, and Hofmann left London for Berlin in 1864. Not until the war of 1914-18 came a public realization of the importance to Britain of a strong organic chemical industry, with a particular emphasis on the key industry of organic dyes.

In the half-century between Hofmann's departure and the first world war there was a remarkable expansion of academic organic chemistry, in which British chemists, although receiving little encouragement, played a worthy role. Among these investigators, most of whom occupied professorial chairs, such typical representatives come to mind as H. T. Brown in the chemistry of brewing, R. Meldola in the chemistry of dyes, W. H. Perkin junior in the terpene and alkaloid fields, F. S. Kipping in the organic chemistry of silicon, Sir Arthur Harden in bacterial chemistry, Sir William Pope in stereochemistry, and Sir James Irvine and Sir Norman Haworth in sugar chemistry.

In the subsequent period, astonishing progress has been made in these and other fields of organic chemistry. As illustrations of the outstanding achievements of British chemists it is sufficient to mention the contributions of contemporary workers, among whom Sir Robert Robinson is preeminent, in such diverse fields as the chemistry of alkaloids, anthocyanins, terpenes, steroids, sugars, complex carbohydrates, vitamins, natural pigments, synthetic dyes, phthalocyanines, high polymers, acetylenic compounds, stereochemistry, and the electronic interpretation of organic reactions.

Sir Frederick Gowland Hopkins' work on vitamins (1906-12) opened up a vast new field of primary importance, to which other British workers have made contributions of high value, including the first synthesis of a member of this class, vitamin C (1933). The discovery of adrenaline, the first hormone to be synthesized, may be traced back to the work of Sir Edward Schaefer and G. Oliver, in 1894, on the medulla of the adrenal gland. Sir William Bayliss and E. H. Starling's original recognition of a hormone (1902), the successful study by British investigators of the pituitary (1909) and thyroid (1914) hormones, and the isolation (1921) and manufacture of insulin, are landmarks in the development of this second field, in which the sex hormones and cortisone have provided new centers of interest. In a third field, original British work by Sir Alexander Fleming (1929) on the inhibiting effect of moulds on the growth of organisms, culminating in the British isolation and investigation of peni-

cillin by Sir Howard Florey and E. Chain and the Anglo-American achievement of its commercial production during the second world war, has led to the study of streptomycin and other natural antibiotics of much significance in chemotherapy.

In the domain of synthetic drugs

and chemotherapeutic agents, the earlier success of novocaine has been matched more recently by the elaboration in Britain of the sulphonamides, of Paludrine, and of an effective antidote to mustard gas. These achievements are to be welcomed as heralds of the approach of a rational system of therapeutics.

## *First Crystal Virus From Animal*

► FOR THE FIRST time, a crystalline virus-like material has been obtained from an animal growth. The material was obtained from warts growing on human skin.

This material consisting of spherical particles, is not only virus in nature but is responsible for the appearance and growth of the wart, Dr. Joseph L. Melnick of Yale University

School of Medicine declared at the conference on viruses and cancer held recently under the auspices of the New York Academy of Sciences.

The crystals which apparently are the virus cause of warts were obtained in research by Dr. Melnick and Drs. Henry Bunting, William G. Bansfeld and Maurice J. Strauss, also of Yale School of Medicine.

## *Sparks Put to Useful Work*

► SPARKS which destroy have been put to constructive work. A new invention utilizes the same kind of sparks which destroy automobile distributor points and erode electrical switches for shaping metals which cannot be shaped by machinery.

The new method electronically controls the intensity and duration of the spark. The result is work with an accuracy as close as .0005 inch.

News of the invention appeared in Russian journals translated in this country in 1948. Simultaneously, it is claimed, it was independently invented in this country by Edmund E. Teubner, who then formed the Method X Corporation of Pittsburgh. Later,

Method X was bought by the Firth Sterling Steel and Carbide Corporation, Pittsburgh.

In this new method, screw threads, round or shaped holes and other incisions in metals which cannot be made by machining can be made by the condensed spark discharge. A reverse picture of the tool is made and the sparks jump between that and the metal which is to be formed.

Firth believes that it has advanced the method far beyond that described in the Russian journals. The process is expensive, it is said, but since the parts cannot otherwise be machined, the expense is justified.

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